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McBride's "Practical Folk Medicine of Hawaii," and opinions about Tacca hawaiiensis versus Tacca leontopetaloides and other taxa

Otto & Isa Degener

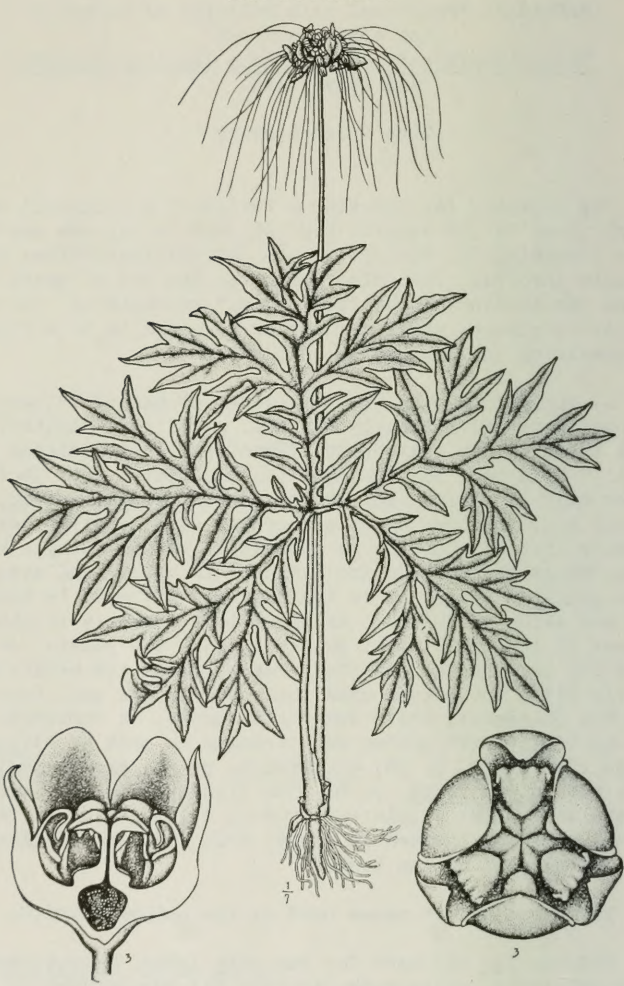
The occasion for printing a review of a botanical or other work gives us the opportunity not only to express our opinions regarding it, but to discuss the identifications of any plants involved. Some discrepancy in the use of names arises from our tendency to be "splitters," emphasizing the differences in plants; while the author may tend to be a "lumper," emphasizing the likenesses in plants.

L. Richard McBride, former Ranger of Hawaii Volcanoes National Park and presently Lecturer at Kilauea Military Camp, has authored his sixth book: "Practical Folk Medicine of Hawaii." This book of 104 pages is illustrated with 84 figures, over half of plants used by the ancient kahunalapa'au, or medicine man. McBride, under one of his nine headings, warns the reader that his "doctor be consulted" before using a home remedy. Hence the book is not a danger to health and even life of the gullible reader as is the disaster authored by Kaalakamana and Akina in 1922 and unfortunately recently reprinted. Pages 22 through 75 deal primarily with the plants, or simples, and the parts used; and their descriptions and habitats. McBride gives the plants used their vernacular and, according to his judgement, their scientific names. As mentioned above, we as "splitters" prefer such changes be made as Allium, on page 23; Pariti, p. 34; citrifolia, p. 55; gaudichaudii, p. 58; and quinquefolia, p. 62. The illustration for page 39 appears to be just a printer's error. A discussion of "Ailments commonly Treated in Hawaii Folk Medicine" follows the botanical part of the book.

Three scientific names used by the author intrique us:

McBride (p. 57) used for our ohia lehua, Metrosideros collina subsp. polymorpha, a trinomial popularized by J.F. Rock over fifty years ago. As we have no incontestable proof that this is correct, we stubbornly still use our catchall "M. polymorpha Gaud., s. l.," for most of these common Hawaiian trees. We have collected Metrosideros taxa in the wild in Fiji, and both in the wild and as a beautiful street tree in New Zealand. Should we relegate all such ohia lehua to mere subordinate taxa of M. collina (J.R. & G. Forst.) Gray, native to distant Tahiti? They don't look

TACCACEAE
TACCA FAMILY



TACCA HAWAIIENSIS Limpricht f.
(Original)
(Described on preceding page)
(Otto Degener, 11/3/'32) (Kapoho, Hawaii)

Tacca Leontopetaloides (Linn.) O. Kuntze

Amman(n), P. Comment. Acad. Sci. Petrop.
8: Pl. 13. 1741, after Merrill

it. That the seeds are wind-disseminated is not sufficiently convincing for us to change our opinion. We are eagerly awaiting a monograph of the genus based, not on casual observation of herbarium sheets, but on facts gleaned with the use of the most recent tools of Science.

"Solanum nigrum" (p. 67), a binomial we have followed for years, is evidently a misidentification. Our popolo is Solanum nodiflorum subsp. nutans R.J. Henderson (1974).

In the Flora Hawaiiensis for November 3, 1932 one of us printed an illustrated description of the local pia he had collected at Kapoho, Island of Hawaii, as Tacca hawaiiensis Limprecht f. Today most workers equate this species with T. leontopetaloides (L.) Ktze., based on a specimen, according to Linaeus (Sp. Pl. 313. 1753), with its "Habitat in India." In fact, Linnaeus refers his binomial to the description and illustrations published by Amman(n) in 1741. As this work is generally unavailable, E.D. Merrill reprinted the Amman(n) plates in the Journ. Arn. Arb. 26: Plate II. 1945. To us, who have had the Hawaiian pia growing in our Mokuleia garden for about forty years and have collected Tacca species in the Hawaiian and Fiji Islands since, T. hawaiiensis and T. leontopetaloides are not conspecific at all but distinct. As pictures can be read in any language, we here dispense with repeating long, technical descriptions in foreign languages. After comparing the plates presently show, doubters can compare original published descriptions for themselves.

"Practical Folk Medicine of Hawaii," selling for $4.50 per copy, caters to the resident and tourist interested in Hawaiiana and local plants in general; not so much to the professional botanist. It is of value to workers in pharmacology of the world as it gives them a clue as to which Hawaiian plants deserve assay. Who knows what medicinal discoveries the kahunalapa'au has made, and how modern chemists may improve on them to enhance their efficacy?

EFFECTIVENESS OF LIME NEUTRALIZATION IN STREAM RECOVERY FROM ACID-MINE POLLUTION AS INDICATED BY SPECIES OF DIATOMS

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Abstract: At one time Slippery Rock Creek Watershed in western Pennsylvania received the effect of acid-mine drainage from approximately 1,000 coal mines. One method of reclaimation tested was the establishment of a lime neutralization plant at the junction of a small, non-polluted stream and a stream experiencing heavy acid pollution. Addition of lime was employed hoping to neutralize the effect of the acid pollution on life downstream. Archibald earlier characterized the results of acid pollution on the algal flora to the level of genera in polluted and non-polluted streams in the Slippery Rock Creek Watershed. Diatoms, in particular, were selected for studying the effectiveness of lime neutralization, because of the manner in which they may be collected, and the wealth of ecological information available at the level of the species. Three sites were studied: (A) polluted stream, (B) non-polluted stream, (C) recovery area below the lime plant. Site B produced diatoms generally associated with small streams of the northeastern United States. The acid stream (A) exhibited growth of species associated with stress, those able to tolerate rapid environmental shifts in a short distance, not species regarded as hard acid stream forms. Species of Nitzchia and Navicula commonly isolated from streams in the recovery stage were found at site (C). As evidenced by collected species of diatoms, lime neutralization can be of value in helping a stream to recover from the effect of heavy acid-mine pollution.

Introduction:

Prior to concentrated efforts of acid-pollution control in the Slippery Rock Creek Watershed, Archibald (1970) and Archibald and Gentile (1971) surveyed the results of such pollution on the local algal flora to the generic level. Chlorophycean representatives were studied in detail. Later, after one of the acid-pollution control projects was in operation for sufficient time to permit measurement of its effectiveness, a second project was undertaken. Diatoms were selected as indicator organisms, because of the manner in which they may be collected and the wealth of ecological information available as to species density and population structures. Archibald conducted the field collections and studied those algal flora other than diatoms. Christensen identified all diatoms and collected known ecological data. Both authors contributed to summarizing the results as reported in this paper.

Selection of Study Site:

At one time the Slippery Rock Creek Watershed in western Pennsylvania received the effect of acid-mine drainage from approximately 1,000 coal mines. One method of reclaimation being tested is lime neutralization of streams experiencing heavy acid-pollution before they flow into non-polluted streams. A plant for this purpose was built 7 miles northeast of Harrisville, Pennsylvania, in Butler County. At this point a small stream heavily polluted with acid wastes enters the headwaters of the North Branch of Slippery Rock Creek before the North Branch flows into the main stream just below Boyers, Pennsylvania.

Slide collection boxes were placed in 3 stream sites (Fig 1) on the lime plant's property so that continuous collections of material could be made. Collection boxes not on state protected property usually are destroyed by local inhabitants.

Site A. Acid-pollution stream prior to entry into storage lagoon for lime neutralization treatment. The pH[1] varies from 4.0 -5.5 depending on the rate of surface run-off and pattern of water flow; bottom is rocky; stream shallow, usually 1-2 ft with a slight flow. Neither insect larvae or minnows are able to survive.

Site B. North Branch of Slippery Rock Creek prior to entry of acid-polluted stream. The pH varies from 6.8-7.2; bottom is rocky; stream is 3-4 ft deep with ripple areas; the stream is free of acid-pollution and supports insect larvae and minnows.

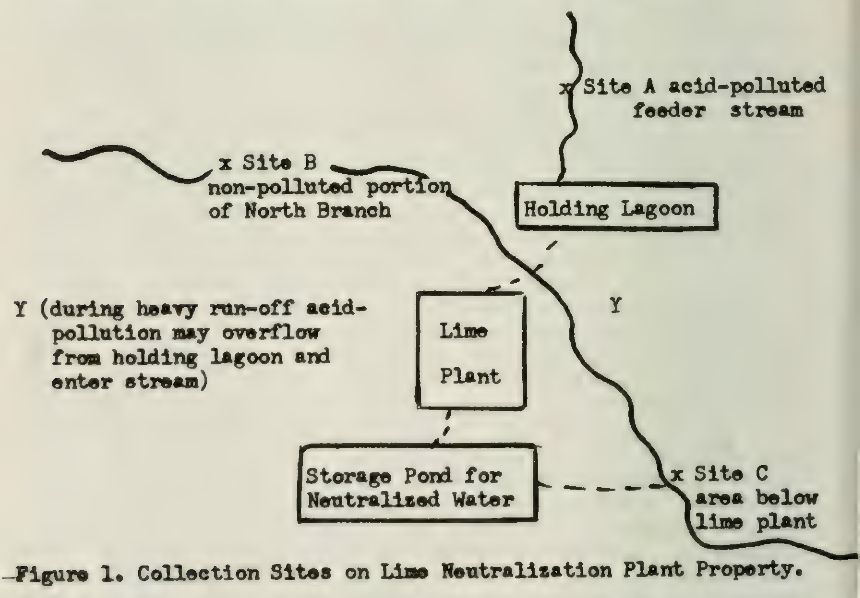

Figure 1. Collection Sites on Lime Neutralization Plant Property.

[1] pH readings supplied by the lime plant personnel from the plant's instruments during the investigation were averaged.

Site C. 25 ft below the introduction of lime neutralized water from the treatment plant. The pH varies from 7.5-8.2; bottom is rocky; stream is 3-4 ft deep with ripple areas; both insect larvae and minnows are found in the stream.

Materials and Methods:

Wooden slide boxes with holes drilled to permit water flow were fitted with clean, untreated glass microscope slides. A box was fastened at each collection site so that it was submerged in a ripple area. Slides were collected every 2 weeks from Oct. 15 to Nov. 19, 1971. Slides collected in the field were placed immediately in a covered slide container so that they were not touching. Slides were transported in this manner to the laboratory and then shipped at a later date to Christensen.

The slides were air dried for several weeks and then weighed to determine the biomass of each slide. The five-slide groups from each collection station were then cleaned using the modified Van Der Werff hydrogen peroxide-potassium dichromate method (Christensen, 1971). To complete the cleaning process the material from each group was boiled in nitric acid for 20 minutes (Patrick and Reimer, 1966). The cleaned material was placed on # 1 cover slips, air dried and mounted in Hyrax on microscope slides. A slide was selected from each collection for use in identification and counting. Relative abundance was determined by completing 5,000 to 10,000 counts on each selected slide under oil immersion.

At different times during the collection period, extensive matts of euglenophycean and chlorophycean filaments appeared on the site bottoms and rocks. Samples of material from the matts were placed in stream water in an uncovered container and immediately transported to the laboratory for identification. Such material also was plated onto inorganically enriched agar plates for maintaince of growth during study in the laboratory.

Results and Discussion:

Growth of phytoplankton in freshwater streams usually is dominated by unicellular chlorophycean genera (Archibald, 1970; Archibald and Gentile, 1971). This growth, however, is not apparent unless a bloom of a specific species occurs. A few species, particularly filamentous forms, may produce dense matts of growth on the stream's floor.

During late summer and fall pronounced matts of growth appeared in all three stream sites. The heavily polluted stream (Site A) had a mixed growth of the filamentous *Oedocladium lewisii* Whitford and *Euglena intermedio* (Klebs) Schmutz. Most of the bottom growth was of *E. intermedio*, a species which has been reported from various habitats (Whitford, 1969). Archibald and Gentile (1971) found that unicellular green algae comprise most of the algal flora during the late summer. Filamentous forms are more common during the spring.

Site B, the "typical" northeastern woodland stream displayed a thick, lush growth of *Microspora amoena* (Kutz) Rabenhorst on the

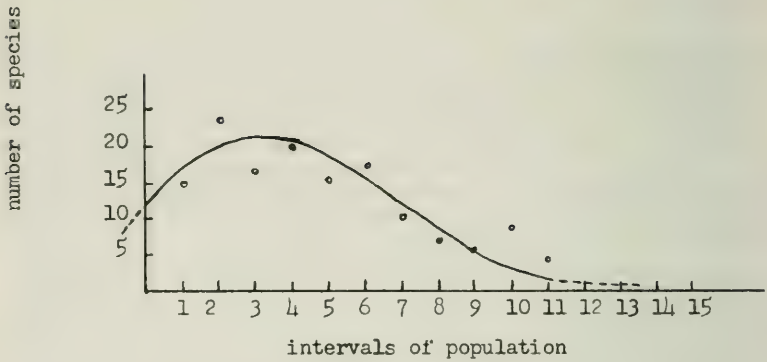

Figure 2 Truncated Normal Curve of Site B.

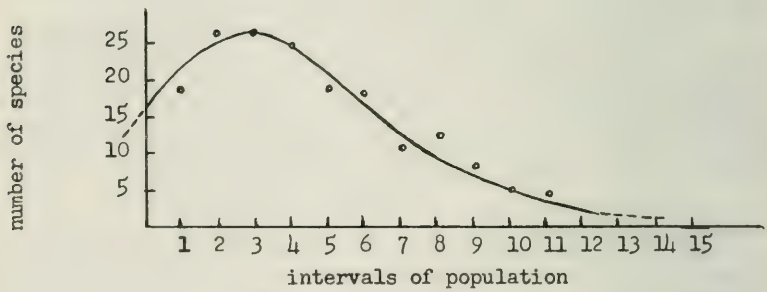

Figure 3 Truncated Normal Curve of Site C

rocks. Spirogyra torta Blum comprised the matt on the stream bed. At times strands of the Spirogyra broke from the matt and floated in the flowing water.

The recovery area, Site C, exhibited an extensive growth of the tetrasporacean species Dispora crucigenioides Printz. Cladophora, a genus common to alkaline waters (Whitford, 1969) also was abundant in Site C. Smith (1955) reported the occasional formation of Cladophora (Aegagropila) holsatica Kutz. into ball-shaped structures. Balls of this species to 0.5 cm in diameter were found growing on the floor of the concrete culvert where the highly alkaline water resulting from lime neutralization enters the stream directly above collection Site C. The force of the discharge water must act in forming the balls as wave action is thought to cause their formation in European lakes.

Table 1. lists the genera and species of diatoms according to site location and pH range. Characteristics from the literature, when available, are included (Lowe, 1970). A total of 22 genera and 129 species of diatoms were identified from the 3 collection sites.

Site A, the acid-polluted stream had 13 genera including 39 species. Pinnularia and Navicula exhibited greater diversity of species at Site A than other genera. Eighteen of the 39 species observed were isolated only from Site A. Five of these species were Pinnularia, and four were Navicula.

Site A is an environment under stress. The population is not typical of a hard acid stream but one under stress from a rapid environmental shift in a short distance and short time span. This is indicated by the drop in species diversity by one-half and the fact that one species, Frustulia rhomboides, represented 87 per cent of the total population. The biomass on the slides was scant and the diatom population slight. Such population structure occurs frequently in streams undergoing stress from low pH pollution as shown by Patrick (1973).

Site B displayed 19 genera and 67 species indicative of a "normal" slightly acid, soft water stream of the northeastern United States. The truncated normal curve developed as a mathematical model by Patrick et al (1954) at this site had the height of the mode at 21 with the curve covering 11 intervals (Fig. 2). The biomass on these slides was moderate and predictable from spring collections. The height of the mode is a little depressed and the tail of the curve is perhaps one interval long for a truly typical situation. This amount of deviation is bo be expected. Twenty-six of the 67 species were not present except at Site B. This particularly was true of species of Cymbella and Nitzschia. There was some indication of a chronic low level pollution at this site which could be from farm drainage, however, it might be just natural conditions.

Site C is located below where the non-polluted stream formerly merged before flowing toward Boyers, Pennsylvania. At present a holding lagoon prevents the acid-polluted water from entering the north branch (Fig. 1). During periods of heavy rain the channel

Table 1.

Diatoms isolated from selected sites of the North Branch of Slippery Rock Creek, Pennsylvania.

species	sites B	sites A	sites C	descriptions
Achnanthes				
A. exigua var. heterovalva Krasska	X			oligosaprobe, littoral stream and lake form
A. hungarica (Grun) Grun. var. hungarica			X	B-mesosaprobe, standing or flowing water
A. lanceolata (Breb) Grun. var. lanceolata	X	X	X	oligosaprobe, rheophil, aerated flowing water
A. lanceolata var. abbreviata Reim.	X			
A. lanceolata var. apiculata Patr.			X	
A. lanceolata var. dubia Grun.	X	X	X	
A. linearis (W. Sm.) Grun. var linearis		X		
A. linearis f. curta H.L. Sm.		X		
A. microcephala (Kutz.) Grun. var. microcephala	X			current indifferent, pH unknown
A. minutissima Kutz. var. minutissima	X	X	X	oligosaprobe, ubiquitous diatom
Amphipleura				
A. pellucida Kutz. var. pellucida	X		X	oligosaprobe, littoral form
Amphora				
A. ovalis Kutz. var. ovalis			X	oligosaprobe
A. ovalis var. pediculus Kuta. Grun. in V.H.	X		X	mesosaprobe, epiphyts highly aerated water
Basillaria				
B. paradoxa Gmelin var. paradoxa	X			euryoxybiont
Cocconeis				
C. placentula var. lineata (Ehr) V.H.			X	oligosaprobe
Cyclotella				
C. meneghiniana Kutz. var. meneghiniana	X		X	euryombiont

Table 1. (continued)

Cymatopleura	B	A	C	
C. solea (Breb) W. Sm. var. solea	X			oligosaprobe, mesooxybiont, littoral form
Cymbella				
C. affinis Kutz. affinis	X		X	oligosaprobe
C. aspera (Ehr.) Cl. var. aspera		X	X	oligosaprobe, littoral form
C. cistula (Hemprich) Grun. var. cristula	X			oligosaprobe, epiphyte
C. cuspidata Kutz. var. cuspidata	X		X	saproxen, pH indifferent
C. gracilis (Rabh.) Cl. var. gracilis			X	
C. gracilis var. ???	X			
C. laeuis Naegli. var. laeuis	X		X	
C. lanceolata (Ehr.) V.H. var. lanceolata	X		X	oligosaprobe, littoral form
C. microcephala Grun. var. microcephala	X			B-mesosaprobe, current indifferent
C. naviculiformis Auerswald var. naviculiformis		X	X	oligosaprob, pH and current indifferent
C. prostata (Berkeley) Cl. var. prostata		X		oligosaprobe, rehophil
C. triangulum Grun. var. triangulum			X	
C. tumida (Breb). V.H. var. tumida		X	X	oligosaprobe, pH indifferent
C. tumidula Grun. var. tumidula	X			saproxen
C. turgida Grun. var. turgida	X		X	oligosaprobe, limnobiont
C. ventricosa Kutz. var. ventricosa	X		X	mesooxybiont, rheopholons, littoral form
Diploneis				
D. ovalis (Hilse) Cl. var. ovalis			X	saproxen
D. ovalis var. ???			X	
Eunotia				
E. arcus Ehr. var. arcus		X	X	saproxen, pH indifferent
E. arcus var. bidens Grun.			X	acidophil
E. curvata (Kutz) Lagerst var. curvata	X		X	

Table 1. (continued)

Eunotia	B	A	C	
E. exigua (Breb. ex Kutz.) Rabh. var. exigua	X	X	X	saproxin
E. major (W. Sm.) Rabh. var. major	X	X	X	
E. monodon Ehr. var. monodon	X	X	X	saproxin
E. pectinalis (Kutz.) Rabh. var. pectinalis	X			oligosaprobe
E. pectinalis var. minor (Kutz.) R.	X	X	X	current indifferent
E. perpusilla Grun. var. perpusilla			X	
Fragilaria				
F. construens (Ehr.) Grun. var. construens	X			oligosaprobe, littoral form
F. construens var. venter (Ehr.)Grun.		X		
Frustulia				
F. rhomboides (Ehr.) Det. var. rhomboides	X	X		saproxen, pH indifferent
F. rhomboides var. amphipleuroides (Grun) Cl.			X	
F. rhomboides var. saxonica (Rabh.) de Toni	X			
F. vulgaris (Thwaites) Det. var. vulgaris	X		X	oligosaprobe
Gomphonema				
G. constrictum var. capitatum (Ehr.) Cl.			X	
G. graciles var. lanceolata (Kutz.) Cl.			X	
G. intricatum Kutz. var. intricatum		X		
G. intricatum var. vibrio (Ehr.) Cl.			X	saproxen
G. intricatum var. ???	X			
G. parvulum Kutz. var. parvulum	X	X	X	pH indifferent, euryoxybiont,
G. parvulum var. lanceolata	X			

Table 1. (continued)

	B	A	C	
Gomphonema				
G. sphaerophorum Ehr. var. sphaerophorum		X		
Melosira				
M. varians Ag. var. varians			X	euryoxybiont, littoral form
Meridion				
M. circulare (Greu.) Ag. var. circulare		X		saproxen, rheophil
Navicula				
N. cryptocephala Kutz. var. cryptocephala	X		X	euryoxybiont, saprophyte
N. cryptocephala var. veneta (Kutz.) Rabh.		X		
N. cuspidata (Kutz.) var. cuspidata		X		
N. gregaria Donk. var. gregaria		X		
N. gysingensis Feged var. gysingensis			X	
N. integra (W. Sm.) Ralfs var. integra	X			mesooxybiont, rheophil
N. laevissima Kutz. var. laevissima			X	
N. lanceolata (Ag.) Kutz. var. lanceolata	X		X	saproxen, littoral and planktonic form
N. pupula var. capitata Hust.	X		X	mesooxybiont
N. pupula var. elliptica Hust.		X		
N. pupula var. rectangularis (Greg.) Grun			X	can stand more minerals than nominate variety
N. pusilla W. Sm. var. pusilla			X	aerophil, polyoxybiont
N. radiosa var. tenella (Breb. ex Kutz.) Grun.			X	oligosaprobe
N. rhynchocephala Kutz. var. rhynchocephala	X		X	mesooxybiont, littoral form
N. salinarum. var. intermedia (Grun.) Cl.			X	water of high mineral content
N. secreta var. opiculata Patr.			X	

Table 1. (continued)

	B	A	C	
Navicula				
N. viridata var. rostellata(Kutz) Cl.			X	mesooxybiont
Neidium				
N. affine var. longiceps (Greg.) Cl.			X	pH indifferent
N. iridis var. ampliatum (Ehr) Cl.			X	oligosaprobe, planktonic form
N. iridis var. ???	X			
Nitzschia				
N. amphibia Grun. var. amphibia		X	X	mesooxybiont, littoral form
N. denticula Grun. var. denticula	X			current indifferent
N. dissipata (Kutz) Grun. var. dissipata		X		mesooxybiont, rheophil
N. dissipata var. media (Kutz) Grun.	X		X	
N. frustulum (Kutz) Grun. var. frustulum	X			mesooxybiont, rheophil
N. gracilis Hantzsch var. gracilis	X		X	
N. obtusa var. scalpelliformis Grun	X		X	
N. pilum Hust. var. pilum			X	euryoxybiont
N. sigma (Kutz) W. Sm. var. sigma	X			mesooxybiont
N. sigmaodea (Nitz.) W. Sm. var. sigmaodea	X			oligosaprobe
N. spectabilis(Ehr.) Ralfs var. spectabilis			X	pH indifferent, oligosaprobe
N. tryblionella var. victoriae Grun			X	mesooxybiont
N. vermicularis (Kutz) W. Sm. var. vermicularis	X			oligosaprobe, rheobiontic
Pinnularia				
P. appendiculata (Ag.) Cl. var. appendiculata		X		
P. biceps Greg. var. biceps	X		X	circumneutral water
P. borealis Ehr. var. borealis		X		
P. braunii var. amphicephala (A. Moyer) Hust.		X		
P. hilseana Jan. var. hilseana		X		

Table 1. (continued)

Pinnularia	B	A	C	
P. mesogongyla Ehr. var. mesogonygyla			X	
P. mesolepta (Ehr.) W. Sm. var. mesolepta	X	X		oligosaprobe
P. microstauron (Ehr.) Cl. var. microstauron	X			oligosaprobe
P. nodosa (Ehr) W. Sm. var. nodosa			X	pH indifferent, oligosaprobe
P. ruttneria Hust. var. ruttneria	X		X	
P. subcapitata Greg. var. subcapitata		X		acidophil
P. viridis (Nitz.) Ehr. var. viridis			X	oligosaprobe, mesooxybiont
Stauroneis				
S. acuta var. terryana Temp. ex. Cl.	X			saproxen
S. anceps Ehr. anceps			X	pH indifferent, mesooxybiont, littoral
S. phoenicenteron f. gracilis (Ehr.)	X	X		pH indifferent
S. smithii Grun. var. smithii		X		
Suriella				
S. angustata Kutz var. angustata			X	euryoxybiont, rheobiont
S. elegans Ehr. var. elegans			X	saproxen, littoral form
S. linearlis var. constricta (Ehr) G.			X	oligosaprobe to saproxen, planktonic form
S. ovata Kutz. var. ovata	X		X	euryoxybiont, rheophil
S. ovata var. pinnata (W. Sm.) Hust.	X			
S. robusta Ehr. var. robusta			X	pH indifferent
Synedra				
S. pulchella Rolfs ex. Kutz var. pulchella	X		X	littoral form
S. rumpens var. meneghiniana Grun.	X		X	
S. rumpens var. ???		X	X	
S. ulna (Nitz) Ehr. var. ulna	X	X	X	mesosaprobe
S. ulna var. clanica (Kutz) V.H.	X			planktonic form
Tabellaria				
T. fenestrata (Lyngb.) Kutz. var. fenestrata			X	saproxen
T. flocculosa (Roth) Kutz. var. flocculosa	X		X	saproxen, acidophil

into the lagoon may overflow and some acid pollution enter the north branch. Due to this fact, Site C was selected below the overflow area and below where the lime neutralized acid-polluted water enters the stream. At point of entry the pH may be as high as 8.5 at times. Site C is 25 ft. below the plant.

Site C with its pH readings above 7 was represented by the greatest species diversity. The biomass on the slides was massive being from 20-25 times greater than the biomass on the slides from Site A. In this case the height of the mode in the normal truncated curve reached 26 but again in 11 intervals(Fig. 3). The species present (Table 1.) are indicative of a diatom population present in the lower recovery zone below a pollution area.

The 19 genera and 80 species isolated from Site C show a stream then recovering from stress. The eight species of Navicula indicate this. The Nitzchia present also tend to indicate organic pollution and a basic pH. Navicula pupula var. rectangularis(Greg) Grun and N. salinarium var. intermedia (Grun) Cl. also are species associated with water having a high mineral content. Thirty-seven of the 80 species were found only in Site C.

Twenty-eight species were common to both Site C and Site B. This was true of six species of Cymbella: C. affinis Jutz. var. affinis, C. cuspidata Kutz. var. cuspidata, C. laeuis Naegli var. laeuis, C. lanceolata (Ehr) V.H. var. lanceolata, C. ventricosa Kutz. var ventricosa, C. turgida Grun. var. turgida. Seven species appeared at both Site C and Site A. Three of these were species of Cymbella: C. aspera (Ehr) Cl. var. aspera, C. naviculiformis Auerswald var naviculiformis, C. tumida (Breb) var. tumida. Only nine of the 129 species occurred in all three environments. Most of these were either species of Achnanthes or Eunotia: A. lanceolata var. dubia Grun, A. lanceolata (Breb) Grun. lanceolata, A. minutissima Kutz var. minutissima; E. exigua (Breb ex Kutz) Babh. var. exigua, E. major (W. Sm.) Rabh. var major, E. monodon Ehr. var. monodon, E. pectinalis var. minor (Kutz) Rabh.

Both planktonic and littoral forms were well represented at all sites. Two epiphytes, Amphora ovalis var. pediculus (Kutz) in V.H. and Cymbella cistuta (Hemprich) Grun. were isolated from Sites C and A. Forms preferring both well aerated, swiftly-flowing water and indifferent current movements were represented at all three sites.

In conclusion this study of diatoms using species types, community structure, and slide biomass has shown that lime neutralization can be of value in helping a stream under stress from acid pollution to recover. A combination of diatom evidence from Site A shows a stream under great pH pollution stress while evaluation of Site B results indicates a "normal" ecologically healthy stream. The collected diatom information from Site C all points toward a stream well on its way to recovery. These results are in good agreement with other known chemical and biological parameters for the study area.

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NOTES ON NEW AND NOTEWORTHY PLANTS. LXXXIX

Harold N. Moldenke

ABRONIA VILLOSA f. RUBESCENS Moldenke, f. nov.

Haec forma a forma typica speciei calycibus rubellis differt.

This form differs from the typical form of the species in having its corolloid calyxes distinctly pure pink or very light pink, rather than deep rose-purple.

The type of the form was collected by Alma L. Moldenke and Harold N. Moldenke (no. 30693) on the desert floor, Mecca, Mohave Desert, Riverside County, California, on April 25, 1976, and is deposited in the Lundell Herbarium at the University of Texas, Dallas. Plants of this form were growing along dry roadsides and on dry road shoulders along with the typical form of the species, but forming very distinct patches or sub-colonies among the normal form, very distinct even from a distance.

AVICENNIA MARINA f. ANGUSTATA Moldenke, Phytologia 23: 425, nom. nud. 1972; f. nov.

Haec forma a forma typica speciei foliorum laminis anguste ellipticis ca. 4—8 cm. longis 1—2.5 cm. latis recedit.

This form differs from the typical form of the species in having its leaf-blades mostly only narrowly elliptic, 4—8 cn. long, and 1—2.5 cm. wide.

The type of this form was collected by Paul Chai (no. S.29949) on consolidated mud near bank in front of Buntal village, Buntal River, First Division, Sarawak, on June 18, 1971, and is deposited in my personal herbarium (at present at Plainfield, New Jersey). The collector describes the plant as a treelet, 4 feet tall, with pneumatophores present, the corollas orange-yellow, and the fruits glaucous-green with a blunt (flat) apex.

CLERODENDRUM KAEMPFERI f. SALMONEUM Moldenke, f. nov.

Haec forma a forma typica speciei corollis salmoneis recedit.

This form differs from the typical form of the species in having its corollas salmon-pink in color during anthesis.

The type of this form was collected by Kai Larsen and Supee S. Larsen (no. 34181) at Khun Yuam, Maehongson, northern Thailand, at 600—700 m. altitude, on September 5, 1974, and is deposited in the Herbarium Jutlandicum ar Aarhus University.

CLERODENDRUM VISCOSUM var. HELFERI Moldenke, var. nov.

Haec varietas a forma typica speciei foliorum laminis ellipticis margine minute serrulatis recedit.

This variety differs from the typical form of the species in having its leaf-blades uniformly elliptic, 11—17 cm. long, 7—10 cm. wide, rather sparsely pilosulous beneath, mostly only minutely serrulate along the margins.

The type of this variety was collected by Johann Wilhelm Helfer (no. 6053) — in whose honor it is named — somewhere in Tenasserim, Burma, in or before 1862, and is deposited in the Torrey Herbarium at the New York Botanical Garden.

GLOSSOCARYA SIAMENSIS var. PUBESCENS Moldenke, var. nov.

Haec varietas a forma typica speciei inflorescentiis densiore patenteque pubescentibus et foliorum laminis subtus plusminusve in venis venulisque pubescentibus recedit.

This variety differs from the typical form of the species in having the pubescence throughout the inflorescence far more dense, conspicuous, and spreading and the lower leaf-surfaces more or less distinctly spreading-pilose-pubescent, especially on the larger venation.

The type of this variety was collected by James F. Maxwell (no. 71-487) in a dense thicket along a trail at Howa Pie, Angthong, Thailand, on August 15, 1971, and is deposited in the Herbarium Jutlandicum at Aarhus University.

LANTANA LEUCOCARPA f. ANOMALA Moldenke, f. nov.

Haec forma a forma typica speciei laminis foliorum uniforme ellipticis vel ovato-ellipticis subtus pauciore puberulis ad basin plerumque perspicue angustatis, fructibus primo albis maturitate purpureis (in locis apricis) vel constante albis (in locis umbrosis) recedit.

This form differs from the typical form of the species in having its leaf-blades of firmer texture, more uniformly narrow-elliptic or elliptic-ovate, conspicuously narrowed at the base, and less densely pubescent beneath, and the fruit changing from white to purple (in sunny places) or remaining white (in shady places).

The type of the form was collected by R. A. Lowden and J. J. Jiménez (Herb. Jiménez 8099) at Marilópez, southeast of the city of Santiago, at an altitude of 180 meters, Dominican Republic, on February 8, 1976, and is deposited in my personal herbarium (at present at Plainfield, New Jersey). The collectors describe the plant as an "Arbusto erecto, ramoso, formando densos matorrales, fuertemente aromático, hasta 80 cm. de altos; flores moradas; fruto desde blanco hasta purpúreo; muy abundante en pasto; suelo seco".

VERBENA DOMINGENSIS f. FOLIOSA Moldenke, f. nov.

Haec forma a forma typica speciei foliis numerosis magnis irregulariter incisis utrinsecus hirtulis recedit.

This form differs from the typical form of the species in having more numerous and larger leaves, ovate in outline, 3—8 cm. long, 2—4 cm. wide, irregularly and deeply incised, conspicuously scattered-hirsute on both surfaces.

The type of this form was collected by Alain H. Liogier (no. 16846) in thickets at the bottom of a gorge or ravine, on limestone, about 5 miles west of Aceitillar, Baoruco Mountains, Peder-

nales, at an altitude of 1400 meters, on November 9, 1969, and deposited in the Britton Herbarium at the New York Botanical Garden. The collector describes the plant as herbaceous, erect, and 60 cm. tall.

VERBENA HALEI f. PARVIFLORA Moldenke, f. nov.

Haec forma a forma typica speciei corollae limbis duplo brevioribus recedit.

This form differs from the typical form of the species in having its corolla-limb about half the size, only about 3 mm. in diameter during full anthesis.

The type of the form was collected by M. C. Johnston, L. A. Johnston, A. Saustrup, D. Darr, and B. Darr (M. C. Johnston 12436b) 0.5 km. from the bay, Galveston Island State Park, Galveston County, Texas, on April 4, 1976, and is deposited in my personal herbarium (at present at Plainfield, New Jersey). The collectors report that it is a very rare form, only a single plant having been seen by them, growing among a profusion of the normal form. They describe it as an erect perennial herb, about 8 dm. tall, the corollas pale flesh-violet in color, the flowers small and crowded in the spike, "apparently not setting seed (?)".

VERBENA RIGIDA f. PARAGUAYENSIS Moldenke, f. nov.

Haec forma a forma typica speciei ramis foliorum laminisque densissime hirtulis recedit.

This form differs from the typical form of the species and its var. reineckii (Briq.) Moldenke in having the stems very densely hirtulous-pubescent and the lower leaf-surfaces much more conspicuously hirtulous-pubescent throughout.

The type of this form was collected by Teodoro Rojas (no. 3407; Hort. Parag. 11794) at Carapegná, Paraguay, in February, 1919, and is deposited in the herbarium of the Botanische Staatssammlung in Munich.

VITEX VESTITA f. QUINQUEFOLIOLATA Moldenke, f. nov.

Haec forma a forma typica speciei foliolis 5 recedit.

This form differs from the typical form of the species and all other described varieties in having 5 leaflets per leaf, the two lowermost very small but otherwise resembling the other three.

The type of this form was collected by James F. Maxwell (no. 73-232) at Muang Ceha, Kritty, Kanchanaburi, Thailand, at 100 m. altitude, on July 9, 1973, and is deposited in the Herbarium Jutlandicum at Aarhus University.

ECONOMIC APPRAISAL OF ENDANGERED PLANT SPECIES

James A. Duke[1]

"Die when I may, I want it said of me by those who know me best, that I plucked a thistle and planted a flower, wherever I thought a flower would grow."[2]

Asked to evaluate economically the candidate list for endangered :d threatened plant species in the continental United States,[3] I faced ıo problems, (1) paucity of economic data on endangered species,) difficulty in eliminating personal biases. The first problem was :leviated by taking a generic approach; the second, by objectively :signing two novices to the compilation. Mary Cepko and Janet Kluve[4] ıre new to economic botany and had developed no biases. They were ımmissioned to compare the candidate species with a cosmopolitan useful ant list and a cosmopolitan weed list we had not used before.

First we alphabetized the list of genera with "listed" species. "listed" species, I define as a species among the proposed candidates r the threatened or endangered species lists.[3] A "listed" genus, I fine as a genus containing one or more "listed" species. Then we nsulted Usher's A DICTIONARY OF PLANTS USED BY MAN[5] and counted the eful species in each "listed" genus. This number, a crude index of ıe world's useful species in each genus, is recorded in Table 1. No menclatural or taxonomic judgments were made. If a useful species was ted under a "listed" genus, the useful species was counted. Then we nsulted a composite world weed index compiled by Sandy Lyon and ıuAnne Morehead[6] by merging the WSSA Weed List (1971),[7] C. R. Gunn's[8] ıpublished list of noxious weed seeds of the 50 States, John Dickson's[9] ıpublished list of tropical weeds in 8 different banana growing areas, ıd Clyde F. Reed's[10] unpublished list of more than 1000 species of weeds ‹otic to the United States. The number of weed species in "listed" genera ı this Composite List is also reported in Table 1. For example, Abutilon ith a score of 12+ and 3- has 12 useful species in Usher, and 3 weed ›ecies in the Composite List. This might be further taken to indicate ıat this genus has more "virtues than vices," that it has a positive :onomic value. On the other hand, Agrimonia with 1 useful species and weed species has a negative economic score.

An obscure species in a genus is more likely to share the economic otential of the genus as a whole, than that of another genus. Hence able 1 objectively hints at the economic potential of a genus, and ence of an obscure listed species in that genus. If a species is obscure ecause of a relict or refugium distribution, it might be argued that t constitutes no weed threat in immediate geological time. However, if he limited distribution of an endangered species is due to recent volution rather than gradual extinction, the species could have weed otential. Weeds cost America about 5 billion dollars per year. About 5% of the worst weeds in the United States are introduced species. At one ime, these weeds also had a very limited distribution in the United

States. If their overseas population had not been known to the student of the American population, these first invaders might well have been classified as endangered species.

Three arguments have been raised for conservation of the "listed" species and I believe all have some merit. I list these in what I think is descending order of economic importance. (1) They could have (an unknown and unpredictable) economic potential in their germplasm (nearly 35% of the listed genera, e.g., have one or more species which have shown some activity in R. E. Perdue's[11] cancer screening program). (2) Species diversity makes an ecosystem more stable. (Diversity could be maintained in a given habitat by substituting a useful species for an endangered species with lesser economic potential. The Plant Taxonomy Laboratory is developing a system using non-endangered plant species as indicators of habitats suitable for endangered species). (3) The preservation of endangered species contributes to the preservation of a natural ecosystem. Are there any natural ecosystems? Are they better than artificial ecosystems? In whose eyes? For worse or better, some Americans prefer a lawn to a savanna, an orchard to a woodlot, and a pine plantation to a virgin forest. There are good reasons for maintaining all these habitats. But Man's introduced exotics have probably crept into nearly all habitats of the United States, so that the natural habitat is already tainted. Is it natural for man to preserve artificially a species that would have suffered extinction naturally? Is it natural for man to increase artifically the numbers of endangered species to the point that some unpredicted weed potential might be unleashed? Whether the answer to these questions is positive or negative, economic criteria should be considered along with aesthetic criteria in determining which habitats and "listed" species deserve more research and more protective measures. We probably have the expertise to save and increase most or all of the "listed" species. But which should be increased? Economic evaluation is important in establishing priorities.

Duke and Terrell[12] list 1000 species in their Crop Diversification Matrix. Only 0.3% of those "crop" species are "listed," Juglans hindsii, Limnanthes bakeri, and a variety of Limnanthes douglasii. Cross checking the "listed" species with the WSSA list, we find only two "listed species: Ceanothus cyaneus and Taxus floridana, on both lists. Although Taxus may be poisonous to cattle, many people, perhaps even the WSSA, would not consider it a weed. In the WSSA list, tree species are included which are not necessarily weeds. Perhaps their composite weed list contains some species which some of their contributors would not regard as weeds. Subtaxa of 14 other "weed" species are "listed", a subspecies of Artemisia cana, Stillingia sylvatica, and varieties of Cerastium arvense, Chrysothamnus nauseosus, Croton glandulosus, Erigeron pulchellus, Ilex opaca, Opuntia imbricata, Oryzopsis hymenoides, Persea borbonia, Quercus shumardii, Rhus trilobata, Rudbeckia triloba, and Sporobolus neglectus.

Some of the tallies in Table 1 surprise me. Usher seems to give more weight to obscure medicinal and ritual than to ornamental uses! I

uld give Helianthus a positive score, since it contains 3 rather portant vegetables, artichoke, sunchoke, and sunflower. Usher cites species of Antirrhinum, the snapdragon genus, but H. M. Cathey,[13] iggests that the annual value of the snapdragon industry in the United ates is in excess of 10 million dollars. I would give Antirrhinum positive (useful) score, but Table 1 scores it neutral. Many of the ass genera (e.g., Digitaria) have more negative (weed) then positive iseful) species according to the Table, but I would give them a positive ore because of their potential for fodder and forage.

With these reservations in mind, and remembering that a useful ecies is defined only as one cited by Usher, and a weed is defined ly as one cited in one of four weed lists, I summarize the table. the more than 500 genera with "listed" species, only about 8% score rictly negative (on at least one weed list, no useful reports), 15% are rictly positive (some useful species, none on weed lists), 25% have more gative than positive scores, while 34% have more positive than negative ecies. The largest category, 41%, represents neutral genera, with as ny useful species as show up on the weed lists. Three-fourths of the nera have positive or neutral scores, only one-fourth have negative ores. Without further study, I would give higher priority to the dangered species in strongly positive genera, lesser priority to e threatened species in strongly negative genera.

Footnotes

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[2]Duke, J. A. and E. E. Terrell. 1974. Crop Diversification Matrix: Introduction. Taxon 23(5/6): 759-799.
[3]Chief, Ornamentals Laboratory, Plant Genetics and Germplasm Institute, Agricultural Research Service, Beltsville, Maryland 20705.

ABRONIA		
ABUTILON	12+	3-
ACACIA	76+	10-
ACANTHOMINTHA		
ACER	13+	10-
ACLEISANTHES		
ACONITUM	13+	1-
AGALINIS		
AGASTACHE	2+	
AGAVE	22+	2-
AGRIMONIA	1+	3-
AGROSTIS	2+	4-
ALETES		
ALLIONIA		1-
ALLIUM	27+	8
ALNUS	12+	6-
AMBROSIA	6+	6-
AMOREUXIA		
AMORPHA	1+	
AMPLIANTHUS		
AMSINCKIA		3-
AMSONIA		
ANCISTROCACTUS		
ANDRACHNE		
ANDROPOGON	11+	15-
ANEMONE	11+	
ANGELICA	11+	1-
ANTENNARIA		3-
ANTHERICUM		
ANTIRRHINUM		
APIOS	1+	1-
AQUILEGIA	2+	1-
ARABIS		
ARCEUTHOBIUM		
ARCTOMECON		
ARCTOSTAPHYLOS	5+	12-
ARENARIA	2+	1-
ARGEMONE	2+	4-
ARSYTHAMNIA		
ARISTIDA	1+	4-
ARNICA	2+	
ARTEMISIA	26+	23-
ASCLEPIAS		17-
ASIMINA	2+	
ASPLENIUM	2+	1-
ASTER	2+	14-
ASTRAGALUS	32+	24-
ASTRANTHIUM		
ATRIPLEX	10+	17-
AUREOLARIA		
BACOPA	1+	3-
BAHIA		
BALDUINA		
BALSAMORHIZA	3+	
BAPTISIA	3+	1-
BARTONIA		
BERBERIS	11+	4-
BLENNOSPERMA		
BOLTONIA	1+	
BONAMIA		
BOTHRIOCHLOA	2+	1-
BOTRYCHIUM	1+	
BRAYA		
BRAZORIA		
BRICKELLIA	1+	
BRODIAEA	1+	
BROMUS	6+	19-
BRONGNIARTIA		
BUCKLEYA		
BUMELIA	3+	2-
CACALIA		1-
CAESALPINIA	20+	3-
CALAMAGROSTIS		1-
CALAMINTHA	2+	3-
CALAMOVILFA	1+	
CALLIANDRA	3+	
CALLIRHOE	3+	
CALOCHORTUS	5+	
CALYSTEGIA	1+	
CAMASSIA	2+	
CAMISSONIA		
CAMPANULA	3+	2-
CARDAMINE	4+	3-
CAREX	12+	19-
CARPENTERIA		
CASSIA	32+	17-
CASTANEA	7+	2-
CASTILLEJA		2-
CAULANTHUS	1+	
CAULOSTRAMINA		
CEANOTHUS	2+	13-
CENTAURIUM	2+	
CENTROSEMA	2+	3-
CERASTIUM	1+	3-
CERCOCARPUS	3+	3-
CEREUS		
CHAENACTIS		
CHAETOPAPPA		
CHAMAESYCE		
CHEILANTHES	1+	
CHIONANTHUS	1+	
CHLORIS	1+	8-
CHLOROGALUM	1+	1-
CHOISYA		
CHORIZANTHE		
CHRYSOTHAMNUS	2+	6-
CIMICIFUGA	2+	
CIRSIUM	9+	15-
CLARKIA		
CLAYTONIA	5+	
CLEMATIS	9+	4-
CLEOME	7+	5-
CLITORIA	3+	1-
COLLINSIA	1+	1-
COLLOMIA		1-
COLUBRINA	4+	1-
COMMELINA		16-
CONDALIA	3+	2-
CONRADINA		
CORDYLANTHUS	1+	
COREOPSIS	2+	1-
CORYDALIS	4+	1-
CORYPHANTHA		
COURSETIA	1+	
COWANIA	1+	
CRATAEGUS	12+	6-
CROOMIA		
CROSSOSOMA		
CROTON	24+	9-
CRYPTANTHA		
CTENIUM		
CUCURBITA	5+	3-
CUPHEA	1+	2-
CUPRESSUS	8+	
CUSCUTA	1+	24-
CYCLADENIA		
CYCLODON		
CYMOPHYLLUS		
CYMOPTERUS	5+	1-
CYPERUS	23+	35-
CYPRIPEDIUM	1+	
DALEA	4+	
DARLINGTONIA		
DASYNOTUS		
DELPHINIUM	7+	13-
DESMODIUM	10+	13-
DICENTRA	2+	
DICERANDRA		
DIGITARIA	10+	21-
DIONAEA		

DIPLACUS		
DITAXIS	1+	
DODECATHEON	1+	
DOUGLASIA		
DRABA		1-
DUDLEYA		
DYSCHORISTE		
DYSSODIA		1-
ECHEVERIA		
ECHINACEA	2+	
ECHINOCACTUS	1+	
ECHINOCEREUS	3+	
ELEOCHARIS	4+	16-
ELLIOTTIA		
ELYTRARIA	1+	
ENCELIA	1+	1-
ENCELIOPSIS		
ENCYCLIA		
EPHEDRA	11+	2-
EPILOBIUM	1+	3-
EPITHELANTHA		
ERAGROSTIS	4+	20-
ERIASTRUM		
ERIGERON	2+	8-
ERIOCAULON		4-
ERIOCHLOA	2+	2-
ERIODICTYON	2+	
ERIOGONUM	4+	1-
ERIOPHYLLUM		
ERRAZURIZIA		
ERYNGIUM	12+	11-
ERYSIMUM	1+	4-
ERYTHRONIUM	3+	
ESCHSCHOLZIA	1+	1-
EUPATORIUM	14+	15-
EUPHORBIA	36+	37-
EURYTAENIA		
EUTREMA	1+	
FEROCACTUS	2+	
FESTUCA	5+	5-
FILIPENDULA	1+	
FIMBRISTYLIS	3+	9-
FORESTIERA	1+	3-
FORSELLESIA		
FOTHERGILLA		
FRANKENIA	4+	
FRASERA	1+	
FRAXINUS	11+	8-
FREMONTODENDRON	1+	
FRITILLARIA	5+	
GALACTIA	1+	1-
GALINSOGA	1+	2-
GALIUM	2+	9-
GAURA		6-
GAYA		
GENISTIDIUM		
GENTIANA	5+	1-
GEOCARPON		
GERANIUM	7+	11-
GEUM	2+	2-
GILIA	2+	
GILMANIA		
GLAUCOCARPUM		
GLYCERIA	1+	6-
GNAPHALIUM	3+	16-
GRAMMITIS		
GRATIOLA	1+	4-
GRINDELIA	2+	1-
GUTIERREZIA	1+	4-
GYMNOCARPIUM		
GYMNOPOGON		
HACKELIA		1-
HALIMOLOBOS		
HAPLOPAPPUS	2+	5-
HARPEROCALLIS		
HARTWRIGHTIA		
HEDEOMA	1+	1-
HEIMIA		
HELENIUM	2+	5-
HELIANTHELLA		
HELIANTHEMUM	1+	
HELIANTHUS	6+	7-
HELIOTROPIUM	4+	18-
HEMIZONIA		1-
HESPEROLINON		
HETEROTHECA		1-
HEUCHERA		
HEXALECTRIS		
HEXASTYLIS		
HIBISCUS	17+	6-
HIERACIUM	1+	7-
HOFFMANNSEGGIA	1+	1-
HOLOCARPHA		
HORKELIA		
HOUSTONIA		
HUDSONIA		
HULSEA		
HYDROPHYLLUM	3+	
HYMENOCALLIS	1+	1-
HYMENOPAPPUS	2+	
HYMENOXYS		2-
HYPERICUM	6+	9-
HYPOXIS	1+	
ILEX	20+	5-
ILIAMNA		
ILLICIUM	3+	
IPOMOEA		42-
IRIS	11+	3-
ISOETES	1+	
ISOTRIA		
IVESIA		
JACQUEMONTIA	1+	2-
JAMESIANTHUS		
JUGLANS	14+	3-
JUNCUS	4+	18-
JUSTICIA	1+	6-
KALMIA	1+	3-
KOSTELETZKYA	1+	1-
LACHNOCAULON		
LAPHAMIA		
LASTHENIA		
LATHYRUS	15+	12-
LAVATERA	2+	2-
LAYIA		
LEAVENWORTHIA		
LECHEA		
LEGENERE		
LEPANTHOPSIS		
LEPIDIUM	6+	11-
LEPTODACTYLON		
LESPEDEZA	4+	5-
LESQUERELLA		1-
LEWISIA	1+	
LIATRIS	3+	
LILIUM	20+	
LIMNANTHES		
LIMONIUM	1+	
LIMOSELLA		
LINANTHUS		
LINDERA	3+	1-
LINDERNIA	1+	6-
LINUM	5+	7-
LISTERA		
LITSEA	8+	
LOMATIUM	5+	1-
LOTUS	1+	5-
LUINA		
LUPINUS	5+	11-
LYCIUM	8+	6-
LYONOTHAMNUS		

LYTHRUM	1+	5-	OXYTROPIS		5-	PRENANTHES	2+	
MACBRIDEA			PANICUM	21+	48-	PRIMULA	3+	
MACHAERANTHERA	2+		PAPAVER	3+	4-	PROBOSCIDEA		1-
MAGNOLIA	10+		PARNASSIA			PRUNUS	32+	10-
MALACOTHAMNUS			PARONYCHIA	2+	1-	PSEUDOBAHIA		
MALACOTHRIX			PARRYA			PSORALEA	8+	3-
MAMILLARIA		1-	PARTHENIUM	3+	1-	PTILIMNIUM		
MANIHOT	7+	1-	PARVISEDUM			PUCCINELLIA	1+	3-
MANISURIS			PECTIS	2+		PYCHANTHEMUM		
MARGARANTHUS			PEDICULARIS	2+	1-	PYXIDANTHERA		
MARSHALLIA			PEDIOCACTUS			QUERCUS	60+	45-
MATELEA			PENSTEMON	1+	3-	RAILLARDELLA		
MAURANDYA			PENTACHAETA			RANUNCULUS	5+	20-
MELANTHERA			PERIDERIDIA			RHAPIDOPHYLLUM		
MENTZELIA	1+	1-	PERITYLE			RHEXIA		
MERTENSIA	1+		PERSEA	6+	2-	RHINANTHUS		5-
MICRANTHEMUM			PERSICARIA		1-	RHODODENDRON	4+	6-
MICROSERIS			PETALONYX			RHUS	21+	14-
MIMULUS			PETALOSTEMUM	2+		RHYNCHOSIA	4+	3-
MIRABILIS	1+		PETERIA			RHYNCHOSPORA		1-
MONARDA	3+		PETROPHYTUM			RHYSOPTERUS		
MONARDELLA	1+		PHACELIA	1+	2-	RIBES	14+	27-
MONOTROPSIS			PHILADELPHUS	1+		RORIPPA		6-
MUHLENBERGIA	1+	4-	PHIPPSIA			ROSA	11+	10-
MUILLA			PHLOX	1+		ROYSTONEA	2+	
MYRCIANTHES			PHYLLANTHUS		4-	RUBUS	40+	19-
MYRIOPHYLLUM		5-	PHYLLITIS	1+		RUDBECKIA		5-
NAMA		1-	PHYSARIA			RUELLIA		2-
NAVARRETIA		2-	PHYSOSTEGIA		1-	RUMEX	17+	29-
NEMACLADUS			PIERIS			SAGITTARIA	2+	9-
NEMASTY			PINCKNEYA	1+		SALIX	19+	13-
NEOLLOYDIA			PINGUICULA	1+		SALVIA	19+	14-
NEOPARRYA			PITYOPUS			SANICULA	2+	
NEOSTAPFIA			PLAGIOBOTHRYS			SARRACENIA	2+	
NESTRONIA			PLATANTHERA	1+		SATUREJA	5+	
NEVIUSIA			PLEUROPOGON			SAXIFRAGA	3+	
NITROPHILA			PLUMMERA			SCHISANDRA		
NOLINA	3+	2-	POA	11+	15-	SCHIZACHYRUM		1-
NOTHOLAENA			POGOGYNE	1+		SCHIZAEA		
NUPHAR	3+		POLEMONIUM	2+	1-	SCHOENOLIRION		
OENOTHERA	1+	6-	POLIANTHES	1+		SCIRPUS	9+	17-
ONOSMODIUM			POLYGALA	17+		SCLEROCACTUS		
OPHIOGLOSSUM	4+		POLYGONELLA			SCROPHULARIA	2+	2-
OPUNTIA	19+	14-	POLYGONUM	17+	49-	SCUTELLARIA	2+	
ORCUTTIA			POLYSTICHUM		1-	SEDUM	7+	5-
OROBANCHE	4+	3-	POPULUS	13+	10-	SELENIA		
ORTHOCARPUS			POROPHYLLUM		1-	SENECIO	14+	24-
ORYZOPSIS	1+	1-	PORTULACA	5+	3-	SHORTIA		
OSTRYA	3+	1-	POTAMOGETON	1+	21-	SIBARA		1-
OXYPOLIS			POTENTILLA	9+	13-	SIDA	4+	12-

SIDALCEA		
SILENE	3+	11-
SILPHIUM	2+	1-
SISYMBRIUM	3+	11-
SIUM	3+	2-
SMELOWSKIA		
SMILAX	20+	7-
SOLANUM	42+	30-
SOLIDAGO	10+	
SOPHORA	8+	9-
SPHAERALCEA	1+	4-
SPHENOSTIGMA		
SPIGELIA	4+	2-
SPIRANTHES	1+	
SPOROBOLUS	4+	10-
STACHYS	5+	7-
STEIRONEMA		
STELLARIA	1+	3-
STENANDRIUM		
STEPHANOMERIA		1-
STILLINGIA	1+	1-
STIPA	6+	11-
STREPTANTHUS		
STYRAX	7+	
SUAEDA		2-
SULLIVANTIA		
SWALLENIA		
SYMPHORICARPOS	1+	3-
SYNANDRA		
SYNTHYRIS		
TAGETES	4+	1-
TALINUM	4+	3-
TANACETUM	1+	2-
TARAXACUM	3+	7-
TAUSCHIA		
TAXUS	4+	2-
TECTARIA	2+	
TEPHROSIA	9+	1-
TETRACOCCUS		
THALICTRUM	5+	2-
THELOCACTUS		
THELYPODIUM		
THERMOPSIS	1+	2-
THLASPI	1+	2-
THYSANOCARPUS		
TOFIELDIA		
TORREYA	3+	1-
TOWNSENDIA		
TRACYINA		
TRADESCANTIA	1+	3-
TRAGIA		1-
TRICHOSTEMA		1-
TRIFOLIUM	24+	12-
TRILLIUM	2+	
TRIPHORA		1-
TRIPSACUM	2+	2-
TRITELEIA		
TROLLIUS		
TROPIDOCARPUM		
URTICA	9+	7-
VACCINIUM	19+	8-
VALERIANA	5+	
VANCOUVERIA		
VANQUELINIA		
VERATRUM	3+	4-
VERBENA	2+	7-
VERBESINA	2+	2-
VERNONIA	12+	7-
VERONICA	4+	17-
VIBURNUM	6+	7-
VICIA	15+	13-
VIGUIERA		2-
VIOLA	5+	10-
WALDSTEINIA		
WAREA		
WILLKOMNIA		
WOODSIA		
WYETHIA	2+	1-
XYRIS	4+	
ZAMIA	4+	
ZANTHOXYLUM	16+	3-
ZEPHYRANTHES	1+	1-
ZIZANIA	2+	2-
ZIZIA		

Table 1. Economic Evaluation of Genera with Endangered or Threatened Species (___+, number of useful species listed in Usher, ___-, number of weed species in composite weed list compiled in Plant Taxonomy Laboratory.

<u>WIKSTROEMIA</u> <u>PERDITA</u> DEG. & DEG., AN EXTINCT (?) ENDEMIC OF A PARADISE LOST BY EXOTIC PRIMATES

Otto & Isa Degener

The genus <u>Wikstroemia</u> of the <u>Thymelaeaceae</u>, as occurring in the Hawaiian Archipelago, was studied by Dr. Carl Johan Fredrik Skottsberg (12/1/80-6/14/63) of Göteborg, Sweden, in the field in 1922, 1926, 1938 and 1948. His early studies were continued in great detail with the loan from about thirty institutions of over 600 historical numbers of which many have been exterminated in this Bulldozer Age of Biotic Destruction. He recognized 38 named taxa before his death; the major part of his study had ended less than a year before, as his letter indicates.

Skottsberg's handwritten manuscript was completed and posthumously published by Bo Peterson of the "Botaniska Museet, Göteborgs Universitet" who, according to his letter dated March 17, 1973, plans "to be able to publish some additions - - - and to make up a key for the species." We corrected the almost perfect English text, paying particular attention to the confused spelling of Hawaiian names before publication of the monograph as "The Genus Wikstroemia Endl. in the Hawaiian Islands." Acta Regiae Societatis Scientiarum et Litterarum Gothoburgensis. Bot. 1:1-166. 1972.

Driving in our jeep last January along the coastal road, Hawaii Volcanoes National Park, toward Wahaula <u>heiau</u> (temple) in search of ephemeral, halophytic <u>Panicum</u> species, we were amazed to see <u>mauka</u> (mountainward) fresh gashes in an endemic jungle never penetrated by botanists before. Reaching there late in the afternoon, we discovered the gashes represented a cleanly bulldozed grid evidently for paved roads in preparation for the sale of house lots. With all workmen gone for the day, we searched for possible botanical prizes. Among the bruised tangle of rare and even unknown taxa, such as a form of <u>maile</u>, <u>Alyxia</u> <u>oliviformis</u>, newly described under an archaic specific name in Phytologia 32:377-385. 1975, we unearthed a single graceful <u>akia</u> lying uprooted on the ground. Even though the butting of the bulldozer had knocked off most of its nocturnal flowers, we saved many of the twigs for museums of the world. We can only wonder what intricate chemicals this plant could synthesize - a plant of a genus cherished for its unique qualities in heathen days for stupefying and catching fish, and for eliminating hated enemies. Even though we failed to find a pistillate specimen, we here name and describe this single <u>akia</u> tree thus far known to us as:

<u>WIKSTROEMIA</u> <u>PERDITA</u> Deg. & Deg., sp. nov. Planta mascula solum cognita: Arbor usque 5 m. alta, glabrata; ramulis gracilibus; inter-

Saro, Sweden, July 30, 1962

My dear Degener,

Thanks very much for the clipping and for the new Flora leaves. The hunting program is a scandal and I cannot understand that it didn't meet with crushing resistance from the conservation people in U.S.A. Mind you, Hawaii is a <u>state</u> now and nothing like this brutality would pass in any other state.

Among the additions to the Flora were two new <u>Canavalias</u>. I see that you have distribute material to a number of herbaria, all perhaps not <u>very</u> important and I am sorry that you came not to think of Stockholm, where I have tried to build up a representative Hawaiian collection! Lots of paramount things are still missing.

Yesterday I finished the analysis of the last Wikstroemias you sent me. As I told you I cannot handle any more now, as I <u>have</u> to get the MS ready.

Best wishes

As ever

Skottsberg

nodis usque 5 cm. longis. Petiolus 5-10 mm. longus; lamina lanceolata, 40-100 mm. longa, 15-25 mm. lata; basi obtusata; apice acuminata. Rhachis 3-5 mm. lomga. Flores strigosi; tubus 44 mm. longus; lobi externi 1.5 mm, interni 1 mm. Pistillodium 1 mm. longum; ovario ½ base nudo, ½ apice densiusculo-setoso.

Staminate plant (pistillate presently unknown) a slender glabrate strict openly twiggy tree 5 meters tall, with 4 cm. thick trunk and smooth reddish brown bark. Leaves distant, in bud antrorsely yellow-puberulent but soon glabrous or nearly so; petiole thin, 5-10 mm. long; blade chartaceous, lanceolate, 4-10 cm. long, 13-25 mm. wide, entire, green and with narrow impressed midrib above, pale green with somewhat salient midrib and prominent veins beneath, acute to acuminate at apex, broadly obtuse at base. Inflorescence long marcescent: peduncle barely 1 mm. thick, antrorsely yellowish puberulent as is rachis, straight but in age retrorsely curved, 2-4 to very rarely 10 mm. long; rachis 1.5 mm. thick, 3-5 to rarely 7 mm. long, unbranched, straight or nearly so, with 25-75 thick minute pedicels from which all nocturnal flowers have been shed except a terminal cluster of 2-5 open ones and up to 20 in various stages of immaturity. Flowers greenish yellow, densely puberulent with antrorse yellowish hair without but glabrous within; tube 4 mm. long; lobes spreading, suborbicular, irregularly crenulate, the outer two 1.5 mm. long and almost as wide but the inner two 1 mm. long and as wide. Stamens with outer pair of oblong anthers extending to apex of tube, inner pair separated by half an anther length below. Aborted pistil 1 mm. long, clavate, lower half glabrous, upper half densely beset with stiff antrorse hair. Hypogynous scales 2, one third length of pistil, ligulate, at apex somewhat acute and entire or somewhat truncate and emarginate.

Type Locality: Known only from "Deg. & Deg. 33,680. (Single staminate 5 meter tree.) *Kalama mauka just beyond Nat. Park Boundary NE of Wahaula, Puna, Hawaii. Bulldozed Metrosideros forest at 1,300 feet. Jan. 23, 1976." Holotype at New York; isotypes widely distributed.

Before the Polynesians discovered the Hawaiian Archipelago several thousand years ago (Phytologia 29:242-246. 1974.), we estimated the endemic Angiosperm flora to have numbered about 50,000 well-recognizable taxa; by the time Capt. Cook rediscovered them in 1778 the endemics had declined to about half that number. With the advent of the bulldozer and the unwitting introduction of exotics, animals as well as plants, the extermination of our endemic plants and the endemic animals dependent upon them for food and shelter is progressing at frightful speed.

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*The orthography was corrected to "Pulama" on all labels before distribution.


PLANTS OF HAWAII
EX HERBARIUM DEGENER
Holotype
33,680
perdita Deg. & Deg.
Kalama mauka just beyond Nat. Park
Boundary NE of
Jan. 23, 1976

Though we are here primarily concerned with Wikstroemia perdita as an example of extermination before our very eyes, we might mention that of the 47 species and 38 subspecies or varieties of endemic birds that enlivened our islands, 22 have become extinct within the last 200 years! The reduction in number of the plants producing their food, such as the red, one-seeded fruit of the akia, is one of the main reasons.

The important factor for the ever-increasing disappearance of the local biota is the poor record up to now of our public schools (Hon. Adv., 1/29-29/76), particularly in the teaching of biology and its appreciation. As a result the State is threatened by biologically ignorant and by tourist-ignoring residents who advocate "the conversion of 5,000 rural acres each year into plantimgs for commercial timber operations (2/4/76)." That means the destruction of our fascinating, biologically incompletely explored jungles for replacement with Australian eucalyptus and Mainland evergreens! These residents maintain that "Hawaii's forests could support after 30 years, a timber industry generating 1,900 jobs and providing an annual net return of nearly $10 million, according to a State report released yesterday (3/24/76). The report noted that almost half of Hawaii's land is in forest and it concluded that half of that - one million acres - is capable of producing a usable timber crop."

Those materialists who are impressed by the questionable promise "of an annual net return of nearly $10 million" thirty years hence from timber should ponder H.N. Moldenke's statement (4/16/76) that "The Hawaiian Islands rank with such other islands as Mauritius and Madagascar in the high percentage of endemism among their flora and fauna. In Mauritius and Madagascar thoughtless men have just about completely decimated their natural heritage (which explains in part why so few scientists, and tourists in general, visit them anymore)." We are gratified Dr. Skottsberg did not live to see such vandalism as the more recent destruction of acres of the endemic, nightblooming Capparis sandwichiana DC., and the brilliant Wikstroemia pulcherrima Skottsb., (Acta Horti Gotob.10:140. 1936.) and its var. petersonii Deg. & Deg. (Phytologia 24:151. 1972.).

We appeal, again, to the botanists of the world to come to this Mecca threatened by lumbering advocates. They should hunt for the unknown pistillate tree of W. perdita and collect, preserve, and record as much of the Hawaiian flora as is still extent so that future, better educated generations shall understand what a splendid Paradise the Islands had been before we idiotic "Primapes" destroyed it for evermore.

STUDIES IN THE HELIANTHEAE (ASTERACEAE). VII.

NOTES ON THE GENUS, *MONACTIS*

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Efforts to identify members of the Heliantheae from Ecuador have shown a concentration of problems in the genus *Monactis*. Neither *Monactis* nor the segregate genera *Astemma* Less. and *Monopholis* Blake have been reevaluated since their original description and treatments at the species level have been erratic. The present preliminary revision attempts to properly delimit the genus *Monactis* and provides necessary new species descriptions and new combinations. Concepts are summarized in two provisional keys to the Ecuadorian and Peruvian species.

The genus *Monactis* was originally described in Nova genera et species plantarum by Humboldt, Bonpland and Kunth in 1818 to include two species from the northern Andes. The characters emphasized were "involucrum oligophyllum, imbricatum, pauciflorum. Receptaculum paleaceum. Flosculi disci nonnulli, tubulosi, hermaphroditi; radii subsolitarius, ligulatus, femineus. Akenia calva." The name was derived from the single-rayed heads of the first species, *M. flaverioides* HBK, resembling the condition found in members of the genus *Flaveria*. The species is sometimes cited as Ecuadorian but the type locality is given as near Jaen which is in Cajamarca, Peru.

The second species of *Monactis*, *M. dubia* HBK of southern Ecuador was described as lacking rays and having reduced stamens. It was suggested that the species was dioecious and on the basis of this suggestion Lessing in 1832 removed the second species as a monotypic genus, *Astemma*. Fragments of the type in the U.S. National Herabrium show that the anthers are aborted but this is regarded as an indication of apomixis rather than a dioecious condition. Other features of the species agree with *Monactis* and the species is close to if not the same as *M. holwayae*.

Bentham and Hooker (1873) recognized both *Astemma* and *Monactis*, the former distinguished as dioecious and the later being placed in a group with inner phyllaries investing the ray achenes. Two species of *Monactis* were cited without providing names and the nature of the supposed second species

remains unknown. Another species was not named in the genus until Monactis jelskii of Peru by Hieronymus (1905).

In addition to a species of Monactis, Hieronymus described two species of Chaenocephalus, C. pallatangensis (1900) of Ecuador and C. jelskii (1905) of Peru. These latter two species were included by Blake (1922) in his new genus Monopholis with two new species, M. hexantha and M. holwayae of southern Ecuador. The genus was typified by M. hexantha. Blake distinguished the genus from the imperfectly known Monactis by the form of the achenes with their single pappus squama. Examination of specimens of Monactis and Monopholis indicates great uniformity of all significant characters except the pappus and the latter is somewhat variable in some species. The pappus distinction was ignored by Chung (1967) in the description of Monactis pentlandii which is evidently a synonym of Monopholis holwayae. There seems to be no reason to continue the distinction of Monopholis and it is regarded here as a synonym of Monactis.

B.L.Robinson (1911) described one other species, Monactis subdeltoidea, having 25 flowers per head and having numerous rays. The species differs from any others placed in Monactis by the numerous flowers, the many phyllaries, the achenes being prismatic and slightly curved from a conical receptacle, and the corollas having short somewhat inflexed lobes and cylindrical throats. The species is not a Monactis but is a synonym of Zaluzania sodiroi Hieron.

The genus Monactis can be delimited by the following combination of characters.

Monactis H.B.K., Nov. Gen. et Sp. 4: 225, t.403. 1818, ed folio. Lectotype: Monactis flaverioides HBK.

Astemma Lessing, Syn. Comp. 216. 1832. Type: Monactis dubia H.B.K.

Monopholis Blake, Bot. Gaz. 74: 416. 1922. Type: Monopholis hexantha Blake

Spreading shrubs with stems often deflected at nodes in zigzag pattern. Leaves alternate, basal wingless portion of petiole short; blade ovate, acute or slightly acuminate, base decurrent on upper half of petiole, trinervate from above base, upper surface scabrid and sparsely glandular-punctate, lower surface thinly to densely tomentose. Inflorescence terminal on branches, massive, corymbose, with branches widely

ascending and bearing decurrent ribs. Heads numerous, sessile or on short pedicels; receptacle small and convex; involucral bracts few, non-herbaceous, in ca. 2 series, with margins or tips narrowly scarious; paleae similar to involucral bracts, larger bases of bracts and paleae partially enclosing bases of achenes; rays 0-2 (3?), female, corolla yellow, tube slender and hirtellous, limb smooth; disk flowers 6-12, corollas yellow; tube thickened at base, narrowed above; limb broadly campanulate, about as long as wide; lobes about twice as long as wide, strongly reflexed at maturity; anthers black, appendages infuscated, glands on connective and appendages; median exothecial cells mostly twice as long as wide, 2-3 nodules on transverse walls, none on sides; nectary narrowly cylindrical without obvious lobes, stomates on upper edge; style immersed about 1/3 into nectary, with distinct small basal node; tips of branches obtusely acute with only papillae extending beyond stigmatic surfaces, longest sweeping hairs in band at base of deltoid tip, inner surface with two stigmatic lines; achenes straight, fusiform, subrostrate above, trigonous to quadrangular, black at maturity, glabrous; carpopodium asymmetric with vein exiting laterally, cells quadrate on the attachment side, longer on the other side, walls firm but only slightly thickened; pappus lacking or with single squama, rarely with two squamae. Pollen ca. 27 μ in diameter, hispidulous.

The most distinctive features of the genus are the coarse alternate leaves and the small heads with few rays or disk flowers. Particularly distinctive are the broadly campanulate throats of the disk flowers and the fusiform trigonous to quadrangular achenes. The genus has some superficial resemblance to Verbesina but the achenes are entirely different and there seems to be no close relationship. Closer relationship may exist with Zaluzania which differs primarily by its larger heads with more flowers and by its differently shaped achenes and disk corollas.

The limited number of specimens and the apparent variation in species results in few specimens agreeing in all characters. As a result the taxonomic value of the various characters has been difficult to determine. One feature, the presence or absence of hairs on the tube of the disk corollas seems consistent for a given specimen but seems to vary within species. Flower number per head often seems to be limited in single specimens but more variable in a species. More reliance has been placed on pappus which is present on

many achenes in some species but is completely lacking in others. Stem pubescence has a similar limited consistency. Long pubescence is characteristic of M. pallatangensis and M. wurdackii but this may be glabrescent as in one specimen seen of the former. Stems of other species such as M. holwayae and M. kingii are, in contrast, always short-puberulous. Rays are also limited to only some of the heads in species where they occur but they are sufficiently numerous to mark the distinction from the rayless species, M. dubia and M. holwayae. Leaf characters seem generally uniform throughout the genus, but M. pallatangensis seems markedly more bullate on the upper surface than any other member of the genus, and M. flaverioides and M. jelskii of Peru seem to have a distinctive subentire leaf margin not seen in other species.

Ecuadorian Species

Four species are recognized from Ecuador with some question regarding the distinction in the rayless forms. The species can be distinguished by the following key.

1. Plants with rays

  2. Upper leaf surface distinctly minutely bullate; stems hirsute . . . . M. pallatangensis

  2. Upper leaf surface smooth or nearly smooth, not bullate; stems short puberulous . . . M. kingii

1. Plants without rays

  3. Anthers aborted, reduced . . . . M. dubia

  3. Anthers normal sized, exerted at maturity M. holwayae

Monactis dubia H.B.K., Nov. Gen. et Sp. 4: 226. 1818, ed folio. Ecuador: Valle Tarquensi, 1300 hex.

Astemma dubium (H.B.K.) Lessing, Syn. Comp. 216. 1832.

The anther reduction of the original description has been confirmed in the few corollas of the type preserved in the U.S. National Herbarium. However, this is taken as evidence of apomixis rather than a

dioecious condition. The anther condition is the only certain distinction between this species and the later described M. holwayae and both species are from the same area near Cuenca in southern Ecuador. Another difference between the species might be the lack of pappus described in M. dubia. The fragments seen show no pappus but the material is too sparing and too immature. The other three Ecuadorian species all have a pappus.

Monactis holwayae (Blake) H.Robinson, comb. nov.

Monopholis holwayae Blake, Bot. Gaz. 74: 419. 1922. Ecuador: Cuenca, Holway & Holway 989 (US).

Monopholis hexantna Blake, Bot. Gaz. 74: 418. 1922. Ecuador: Cuenca, Holway & Holway 973 (US).

Monactis penlandii Chung, Phytologia 14(6): 324. 1967. Ecuador: Banos near Cuenca, 2600 meters, Penland 1068 (isotype US).

The two Blake species were distinguished in his key by supposed differences in pedicel lengths, and examination of the type of Monopholis holwayae does show a denser inflorescence. The inflorescence difference seems, however, to be entirely an artifact of partial immaturity. Age effects not only the density of the inflorescence but also the size of the heads as paleae and achenes become more elongate. Another described difference between the two species is the 6-7 flowers per head in Monopholis hexantha versus the 8-11 in M. holwayae. Individual specimens do seem to have a limited range in flower number, still, some heads of the type of M. hexantha have as many as 8 flowers while other specimens have 7-8, 7-9 and 8-10. The specimens with lower numbers of flowers per head often have narrower leaves and narrower less ridged stems, but these characters do not correlate sufficiently with others. Such plants might simply be from more exposed habitats.

The Chung species seems to have been described in Monactis without knowledge of the species that had been described in Monopholis.

Monactis holwayae is almost completely restricted to the Province of Azuay in Ecuador. One specimen has been seen from, ECUADOR: Cañar: near El Tambo; 9500-10,000 ft. elev., Camp 2429 (NY). This latter is from within the range of M. kingii.

Monactis kingii H.Robinson, sp. nov.

Plantae frutescentes vel subarborescentes usque ad 5 m altae laxe ramosae. Caules teretes vel subangulares striati minute puberuli. Folia alternata, petiolis 0.5-1.5 cm longis; laminae ovatae plerumque 7-12 cm longae et 3-7 cm latae fere ad basem trinervatae base late cuneatae vel subtruncatae subabrupte in petiolis decurrentes margine serratae vel serrulatae apice leniter acuminatae supra non bullatae scabridulae et glanduliferae subtus canescentiter tomentellae in nervis et nervulis saepe fulvo-tomentellae. Inflorescentiae irregulariter corymboso-paniculatae in ramis foliosae, pedicellis 0-2 mm longis minute dense puberulis. Capitula ca. 8-9 mm altae et 3-4 mm latae. Squamae involucri ca. 8 brunnescentes oblongae 2-4 mm longae et 0.5-1.0 mm latae margine indistincte scariosae hirsutae extus puberulae glabrescentes apice anguste rotundatae; paleae squamis involucri similares anguste oblongae 5-6 mm longae et 1.0-1.5 mm latae base achaeniorum parum investientes extus evanescentiter hirsutae glanduliferae. Flores radii 0-2 feminei; corollae flavae, tubis ca. 1 mm longis puberulis, limbis 5-6 mm longis et 2.5-3.5 mm latis apice breviter trilobatis extus pauce glanduliferis. Flores disci 9-10 hermaphroditi; corollae flavae 3.0-3.5 mm longae, tubis ca. 1.0-1.5 mm longis extus hirtellis et glanduliferis vel subglabris, faucis late campanulatis ca. 1 mm longis et latis glabris, lobis ca. 1 mm longis et 0.4-0.5 mm latis glabris vel subglabris; thecae antherarum ca. 1.2 mm longae; appendices ca. 0.3 mm longae. Achaenia fusiformia 4-5 mm longa nigra subtrigona; squama pappi solitaria raro nulla membranacea ca. 1 mm longa oblonga.

TYPE: ECUADOR: Cañar: along the Pan-American Highway (route 1) ca. 2 kms SE of Cañar. elev. ca. 10,400 ft. Several small shrubs or trees to 2 meters tall, open sun, flowers yellow, King 6620 (holotype US; isotypes MO, NY). Paratypes: ECUADOR: Cañar: along the Pan-American Highway (route 1) ca. 13 kms NW of El Tambo. elev. ca. 7800 ft. Abundant small trees, ca. 4-5 meters tall, flowers yellow, King 6623 (US, MO, NY); Dry chaparral scrub and Paramo, with occasional moist valleys, near El Tampo (ac. 69 km by RR south of Sibambe); 9,500-10,00o ft. elev. Lvs. deep green, subscabrous above; pale pubescent below. Bracts green, tipped with yellow. Corolla yellow. Anthers dark brown; stigmas yellow. One flower in head often ligulate. Gilar says that, previously in this region, he has seen this occasionally with two ray flowers in

the head . . ., Camp 2440 (NY); between Tambo and Suscal. North rim of the valley of the río Cañar. Shrubby, 3 m. Plants with many heads with 2 ligulate fls., Camp 2785 (NY).

Monactis kingii superficially resembles M. pallatangensis of the Province of Chimborazo by the presence of ray flowers. Both the upper leaf surface and the stem pubescence indicate a closer relation to M. holwayae of Azuay. There is a tendency for M. kingii to have more broadly ovate and less decurrent leaf blades than are found in M. holwayae but there seem to be exceptions, especially in the rayless specimen from Cañar that has been determined as M. holwayae in this study.

Monactis pallatangensis (Hieron.) H.Robinson, comb. nov.

Chaenocephalus pallatangensis Hieron., Bot. Jahrb. 29: 47. 1905. Ecuador: in valle Pallatanga, Sodiro 38 (frag. US).

Monopholis pallatangensis (Hieron.) Blake, Bot. Gaz. 74: 419. 1922.

The rougher upper leaf surface and the hairer stems distinguish this northernmost member of the genus. One specimen (E.L.Little 6764, US) does not show the longer pubescence, but this is the most mature specimen of the species and the stems are apparently glabrescent.

Peruvian Species

Limited material prevents any definitive results but four species seem to be present.

1. Leaf margins subentire, with remote partially recessed minute mucronations

   2. Pappus lacking; stems lanate, glabrescent? M. flaverioides

   2. Pappus present on most achenes; stems hirtellous M. jelskii

1. Margins of well-developed leaves distinctly serrate

   3. Leaf margins with remote blunt teeth; stems puberulous; pappus present . . . M. hieronymi

3. Leaf margins closely and often sharply serrate; stems densely villose or lanate; pappus never present . . . . *M. wurdackii*

Monactis flaverioides H.B.K., Nov. Gen. et Sp. ed. folio 4: 225. 1818. Peru: Provincia Bracamorensi, inter urbem Jaen et ripam fluminis Amazonum, alt. 250 hex.

Monactis flaveriae DC., Prodr. 5: 546. 1836.

The species was originally illustrated with obtusely acute leaves unlike any other in the genus. A microfiche of the type specimen indicates the leaf tips are badly broken and that aspect of the illustration seems to have been an erroneous reconstruction. The microfiche also indicates that the illustration overemphasizes the marginal teeth which were originally described as "Folia . . . margine denticulis minutissimis obtusis valde remotis instructa." Also, the original genus description says, "Arbores foliis alternis integris: . . ." As such, the species seems closest to *Monactis jelskii* having thinner nearly entire leaves. The branches were originally described as "ramulis . . . glabriusculis" and the achenes are without a pappus, a combination not matched by more recent collections in the genus. It seems likely, however, that the described stem pubescence represents a glabrescent condition such as is seen on older stem parts in two specimens from Peru cited below. It is notable that the puberulent condition which is noted in the original description of *M. dubia* by the same authors, does not seem to be as glabrescent.

PERU: AMAZONAS: Chachapoyas: *Mathews* (NY); Chachapoyas: cerca a Leimebamba, habitat matorral, alt. 2200-2300 m, arbusto 1.50-2 m de alto, *Ferreyra 15547* (US).

Monactis hieronymi H.Robinson, nom. nov.

Chaenocephalus jelskii Hieron., Bot. Jahrb. 36: 494. 1905. Peru: prope Tambillo, *Jelski 698* (isotype US).

Monopholis jelskii (Hieron.) Blake, Bot. Gaz. 74: 420. 1922.

The new name is necessary since the combination *Monactis jelskii* is preoccupied. The species seems

closest to M. wurdackii as noted under that species. The species is known only from the type collected in eastern Piura, Peru.

Monactis jelskii Hieron., Bot. Jahrb. 36: 486. 1905. Peru: prope Cutervo, Jelski 684 (isotype frag. US).

The species seems close to material tentatively included here under M. flaverioides, but the type differs by its puberulous rather than villous stems and its pappus of one or even two squamae.

Monactis wurdackii H.Robinson, sp. nov.

Plantae frutescentes usque ad 5 m altae laxe ramosae. Caules teretes striati dense villosi. Folia alternata, petiolis 1.5-5.0 cm longis; laminae ovatae plerumque 8-14 cm longae et 4.5-9.0 cm latae supra basem trinervatae base late cuneatae subabrupte in petiolis decurrentes margine in foliis inferioribus distincte vel grosse serratae apice acutae vel subacuminatae supra non vel vix bullatae scabridulae et sparse glanduliferae subtus canescentiter tomentellae in nervis et nervulis plerumque fulvescentes. Inflorescentiae irregulariter corymboso-paniculatae in ramis foliosae, pedicellis 0-3 mm longis dense hirtellis. Capitula 8-10 mm alta et 3-4 mm lata. Squamae involucri ca. 10 flavo-virides vel brunnescentes oblongae 2-5 mm longae et 0.5-1.0 mm latae margine indistincte scariosae hirsutae extus puberulae glabescentes apice rotundatae; paleae squamis involucris similares anguste oblongae 5-7 mm longae et ca. 1 mm latae base achaeniorum parum investientes extus evanescentiter hirsutae glanduliferae. Flores radii 0-2 feminei; corollae flavae, tubis ca. 1 mm longis puberulis, limbis 7-8 mm longis et 2-3 mm latis apice minute trilobatis. Flores disci ca. 8-10 hermaphroditi; corollae flavae 3.5-4.0 mm longae, tubis ca. 1.5 mm longis extus hirtellis vel glabris, faucis late campanulatis ca. 1 mm longis et latis glabris, lobis ca. 1.3 mm longis et o.6-0.7 mm latis glabris vel subglabris; thecae antherarum ca. 1.3 mm longae; appendices 0.3-0.4 mm longae. Achaenia ca. 5 mm longa nigra subtrigona vel subquadrangularia; pappus nullus.

TYPE: PERU: Amazonas: Chachapoyas: Rock quarry 1 km southwset of Chachapoyas, elev. 2300 m, Shrub 3-5 m. Rays 0-2, yellow; disc yellow. Locally frequent. Chromosom number n = ca. 30 (B.L.Turner). May 22, 1962. Wurdack 452 (Holotype US; isotype NY).

Paratypes: PERU: Amazonas: Entre Conila y Cohechán. Soukup 4131 (US); CAJAMARCA: Celendin: Canyon Rio Marañon above Balsas, 5 km below summit of road to Celendin. Shrub ca. 4 m. Leaves crisp, densely pubescent beneath. Pubescent stems red-violet toward apices. Rays lemon yellow, disks golden yellow. usually one or two rays per head. Alt. 2930 m. May 24, 1964. Hutchison & Wright 5319 (US, NY).

The new species seems distinct in the closely serrate leaves and in the densely villous stems and petioles. The nearest resemblance is to M. hieronymi which has more remote blunt teeth on the leaves, puberulous stems, and achenes often bearing a small pappus.

There is an additional specimen from Chachapoyas collected by Mathews (K not seen, NY, photo US) which seems close to Monactis wurdackii but it has short pubescence on the stem.

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Monactis kingii H.Robinson, Holotype, United States National Herbarium. Photo by Victor E. Krantz, Staff Photographer, National Museum of Natural History.

Monactis kingii H.Robinson, enlargement of heads.

Monactis wurdackii H.Robinson, Holotype, United States National Herbarium.

STUDIES IN THE LIABEAE (ASTERACEAE). III.

NOTES ON THE GENUS, CACOSMIA.

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The genus Cacosmia HBK was described in 1818 with a single species, C. rugosa, from southern Ecuador. The locality was erroneously given as Peru but the species has since been found in Peru also. A second name, C. quinquenervia Steud., has appeared only in synonymy, but the genus has continued to contain a single described species. In 1901 in his treatment of the Lehmann collections Hieronymus did recognize some diversity in Cacosmia which he treated at the varietal level. The typical variety has articulated hairs on the stems and stipules, ovate to broadly elliptical serrate leaves, and involucres with only the tips of the outer phyllaries violaceous. The variety arachnoidea Hieron. of southern Ecuador had evanescent arachnoid pubescence without intermixed articulated hairs, narrow entire leaves, and dark phyllaries. The variety nivea Hieron. from Peru combined the leaf form and phyllary color of the typical variety with the pubescence of variety arachnoidea. No taxonomic changes have occurred in Cacosmia since the work of Hieronymus.

The genus Cacosmia has been reviewed recently with the intent to treat the genus in the Liabeae of Ecuador. Help has been obtained from new collections from Ecuador by R.M.King with comments on habit and on presence or absence of milky sap. The review has served to emphasize the differences in the extreme variants of the genus as they occur in Ecuador and to indicate that they should be treated as separate species. Another local variety has also been recognized in southern Ecuador and northern Peru. The present treatment puts more emphasis on differences of leaf form and recognizes strictly pubescence differences at the varietal level.

Cacosmia hieronymi H.Robinson, sp. nov.

Plantae frutescentes 1.0-1.5 m altae saepe dense ramosae. Caules teretes striati castanei arachnoideo-pubescentes glabescentes, internodis plerumque 1-4 cm longis. Folia opposita, stipulis connatis vaginatis arachnoideo-pubescentibus sine aut fere sine pilis articulatis glabrescentibus, petiolis 1-2 mm longis;

laminae ovato-lanceolatae vel lanceolatae plerumque 2.0-4.5 cm longae et 0.5-1.5 cm latae margine integrae vel bullato-crenulatae apice acutae supra bullatae in bullis glabrae subtus dense tomentosae obscure glanduliferae fere ad basem trinervatae. Inflorescentiae dense corymbosae vel breviter paniculatae, ramis dense tomentosis; capitula 7-8 mm alta; squamae involucre ca. 25 ca. 5-6-seriatae 1-7 mm longae ovatae vel anguste ellipticae omnino aut plerumque purpurascentes apice anguste rotundatae minute fimbriatae extus glabrae; flores radii 5; corollae flavae, tubis ca. 2 mm longis glanduliferis et hirsutis, limbis ca. 6 mm longis ellipticis; flores disci ca. 6; corollae ca. 5 mm longae extus glanduliferae inferne hirsutae, tubis indistinctis, lobis ca. 2 mm longis; thecae antherarum pallide vel parum brunnescentes 1.8-2.3 mm longae, appendicibus ca. 0.3 mm longis. Achaenia 1.5-2.0 mm longa glabra; pappus nullus.

TYPE: ECUADOR: Azuay: along the road to Loja, ca. 6 kms generally SE of Cumbe, several shrubs to 1 ½ m tall, open area, flowers yellow. Elev. ca. 9600 ft. Feb. 4, 1974. King 6702 (Holotype US). Paratypes: ECUADOR: Mountains of Cuenca and Loja, W.Jameson (US, NY). AZUAY-LOJA: Nudo de Cordillera Occidental y Cordillera Oriental entre Oña y Rancho Ovejero. Between Cumbe (2704 m) and cerca 2800 m, on southbound road. Barclay & Juajibioy 8435 (US). AZUAY: Along the río Tarqui, 4-18 km south of Cuenca; 8300-9000 ft. elev., bases of cliffs, Camp E-1890 (US, NY); Vicinity of Cuenca; 8200-8900 ft. elev. Near union of ríos Tarqui and Yanuncay. Camp E-2635 (NY); Vicinity of Cuenca; 8200-8900 ft. elev. Along río Milchichic. Camp E-2722 (NY); Along the road to Loja, ca. 39 kms S of Cumbe. Elev. ca. 10,200 ft. Locally common shrubs 1 m tall, flowers yellow, no apparent milky sap. King & Garvey 6903 (US); Páramo Alpacada, along Pan-American Highway 82 km south of Cuenca, alt. 9500 ft. Wiggins 10810 (US, NY). CAÑAR: Vicinity of Santa Rosa de Cañar. Rose 22666 (US). LOJA: On road from Loja to Cuenca; elev. 2900 m. Dodson & Thien 854 (US); Saraguro (unos 50 km N. Loja) 2500 m.s.m. Espinosa 1408 (NY); Between San Lucas and Oña. Alt. 2200-3100 m. Hitchcock 21569 (US).

The new species has a distinctive appearance in the narrower lanceolate leaves without obvious teeth in contrast to the oblong or broadly elliptical toothed leaves of C. rugosa. The inflorescence also is usually condensed into one or a few simple often sessile clusters. The most paniculate forms of the inflorescence are like the least developed forms in

C. rugosa. The new species has phyllaries usually mostly purplish while C. rugosa has phyllaries yellowish to brownish with at most the tips purple. A key to the Ecuadorian material of the genus could utilize the difference in stem pubescence, glabrescent arachnoid pubescence without intermixed coarser articulated hairs in C. hieronymi versus mostly coarse articulated persistent hairs in C. rugosa. The C. hieronymi type of pubescence is found, however, in the C. rugosa var. nivea which is known from central Cajamarca south to Huanuco in Peru. The recent King collections from Ecuador have one other possible character of significance. The King 6903 is noted as having no apparent milky sap while a specimen of C. rugosa var. kingii similarly tested had milky sap. The reliability of the character is yet to be proven. The northernmost specimen of the new species, Rose 22666 from Cañar, has a few small teeth on some of the leaves which might indicate introgression with C. rugosa, but other characters are as in typical C. hieronymi.

The new species is evidently the entity named by Hieronymus as Cacosmia rugosa var. arachnoidea, but it has seemed best to provide a new name at the species level with a new type specimen.

Cacosmia rugosa var. kingii H.Robinson, var. nov.

Caules hirsuti, pilis articulatis persistentibus. Folia oblongo-ovata supra in bullis pilosa. Inflorescentiae paniculatae; squamae involucri flavae brunnescentea.

TYPE: PERU: CAJAMARCA: Tabaconas, on Río Tabaconas, 20 km e.s.e. Huancabamba, Prov. de Jaen, gently sloping alluvial fan, somewhat dissected, with grassy pasture, thickets and scattered shrubs. Alt. 1900 m. Common on edges of ravines, shrub 1 m tall; flowers yellow. June 11, 1947. F.R.Fosberg 27777 (Holotype US). Paratypes: PERU: CAJAMARCA: Prov. Jaen: Above Tabaconas, 2300 m. Weberbauer 6304 (US). ECUADOR: LOJA: Along the road to Zamora, ca. 2 kms E of Loja. Elev. ca. 7000 ft., common shrubs 1 m tall, open sun, flowers yellow, sap milky, King & Garvey 6913 (US).

The three specimens all show the distinctive pubescence on the upper surface of the leaves. The bullate surfaces are nearly or completely glabrous in all other specimens of the species. Other characters of C. rugosa var. kingii are as in typical C. rugosa and the former is geographically restricted to areas entirely within the range of the latter. The specimens

are from both Ecuador and Peru but in closely adjacent areas that suggest a natural range along the eastern slopes of the Andes from near Loja in the north to Tabaconas in the south.

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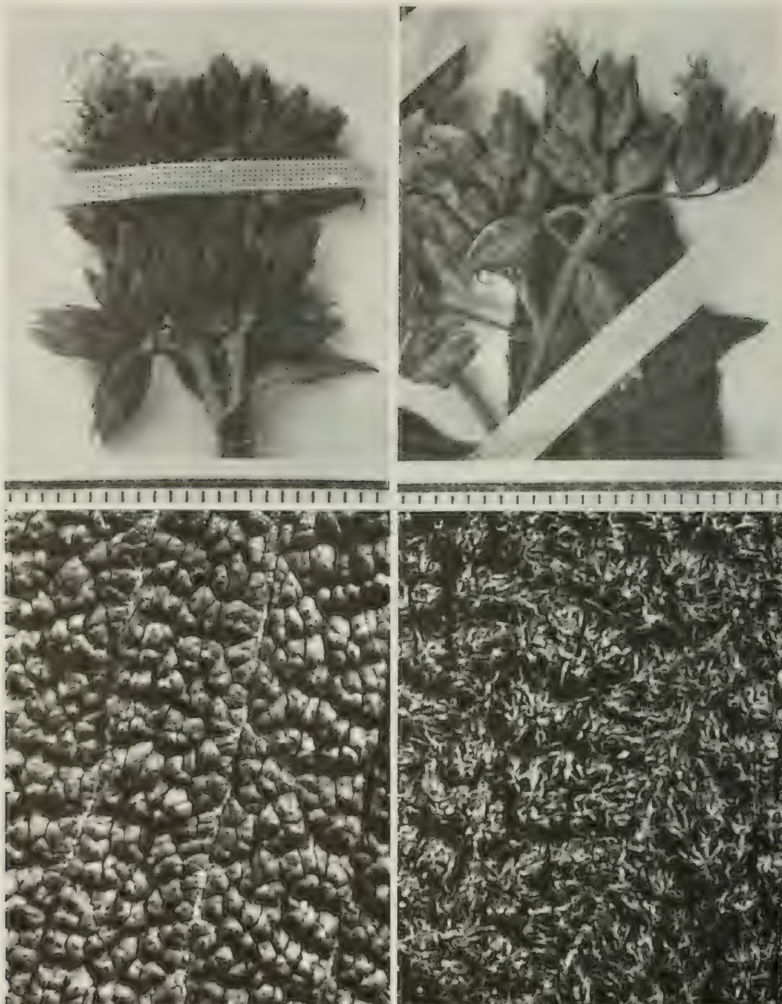
Cacosmia hieronymi H.Robinson, Holotype, United States National Herbarium. Photo by Victor E. Krantz, Staff Photographer, National Museum of Natural History.

Cacosmia rugosa var. kingii H.Robinson, Holotype, United States National Herbarium.



Top: enlargments of heads, Cacosmia hieronymi and C. rugosa var. kingii. Bottom: upper leaf surfaces, C. hieronymi and C. rugosa var. kingii.

STUDIES IN THE LIABEAE (ASTERACEAE). IV.

ADDITIONS TO THE GENUS, PHILOGLOSSA.

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The recent review of the genus Philoglossa DC. (Robinson & Cuatrecasas, 1973) recognized four species concentrated in the region of Peru. Some additional specimens have been seen and two are of special interest. Previous distribution data suggested little or no overlap in the range of the species, but the new collections complicate that picture.

A collection recently distributed under the name of Philoglossa peruviana DC. from within the range of that species lacks the characteristic habit and has on examination proven to be P. pterocarpa Sandwith. The Sandwith species was described from an area well to the northwest in Cajamarca. The data of the new specimen is: PERU: Lima: Central highway ca. 26 km above Chosica - 18 km W of Matucana, G.Edwin & J.Schunke V. 3790. The flowers are noted as pale red. It is notable that P. pterocarpa has been reported once previously from the Lomas near Lima (Nr. 1313, Diers, 1961). The Diers specimen, which is the basis for the only chromosome report in the genus, has not been restudied.

The second collection of note has the superficial habit of P. peruviana but is from Libertad, to the northwest of the known range of that species. Closer examination shows that the specimen is an undescribed species with some particularly distinctive characters. The new species has larger heads with more flowers than any other member of the genus. The material is limited and the number of flowers is estimated from a partial count, but there are not less than 50-60 rays and ca. 50 disk flowers. The rays and outermost disk flowers are yellow as usual for the genus and the tribe, but the inner disk flowers have purple corollas with the red pigment prominent in material mounted on slides. The only other member of the tribe with similar color is Chionopappus Benth. which also has yellow rays and purple disk flowers. The disk corollas of the new species also have very prominent setae near the tips of the lobes. The setae are more like those on the stems and leaves and involucral bracts and

unlike hairs on the corollas of related species. The anther appendage alone will distinguish the new species from P. peruviana, but it is like the other three species of the genus in being oblong with an entire margin. A further distinctive feature of the species is the achene with a fringe of hairs along its margins and a well developed pappus. The pappus normally has two aristae and a series of shorter laciniate squamae. Except for the reduction in the number of aristae to correlate to the number of ribs of the achene, the pappus is like some forms in the genus Munnozia. The pappus in other species of Philoglossa is much more reduced or totally lacking. In spite of the many distinctive features the generic placement can be confirmed not only by the close habit resemblance to P. peruviana but also by the distinctive type of hairs on the stem and by the compressed achenes.

Philoglossa purpureodisca H.Robinson, sp. nov.

Plantae herbaceae base erectae usque ad 40 cm altae pauce ramosae. Caules teretes vel subhexagonales in sicco striati pilosi vel dense pilosi, cellulis 1-3 basilaribus pilorum grosse inflatis. Folia opposita sessilia inferne remota minuta superne in binis duplicibus subverticillata; laminae ovatae 3.5-6.5 cm longae et 2.0-3.5 cm latae base cuneatae margine remote mucronate serratae apice acutae supra pilosae subtus in nervis grosse pilosae inter nervos rigide tenuius antrorse appresse pilosae fere ad basem tri-vel quinque-nervatae. Inflorescentiae in axillis foliorum congestorum unicapitatae, pedicellis usque ad 7 cm longis dense pilosis. Capitula ca. 8-9 mm alta et ca. 1.8 mm lata. Squamae involucri ca. 25 ca. 9 mm longae ca. 2.5 mm latae exteriores oblongae acutae vel obtuse acutae margine dense ciliatae base extus glabrae supra medio chlorophyllosae extus et intus pilosae; squamae interiores lanceolatae anguste acuminatae extus et intus glabrae. Flores radii ca. 70; corollae flavae, tubis ca. 2 mm longis superne hirsutis, pilis hieraceiformibus, limbis ca. 7 mm longis ca. 1.7 mm latis glabris apice emarginatis. Flores disci ca. 50-60; corollae peripherales flavae ceterae purpureae ca, 5 mm longae, tubis 1.7 mm longis glabris, faucis abrupte campanulatis glabris, lobis 2.2-2.8 mm longis ca. 0.6 mm latis ad apicem setiferis, setis 3-4-cellularibus uniseriatis, cellulis 1-2 basilaribus ca. 50μ latis et longis, cellulis apicalibus angustioribus elongatis rigidis minute papillosis; filamenta in parte superiore ca. 250μ longa; thecae 2.2 mm longae; appendices antherarum integrae oblongae ca. 200μ longae et

170μ latae. Achaenia immatura ca. 1 mm longa compressa margine hirtella; pappus biaristatus et multisquamatus, aristis 2.2-2.5 mm longis scabridis, squamis ca. 8 oblongo-lanceolatis apice laciniatis. Grana pollinis ca. 35μ diam.

TYPE: PERU: LIBERTAD: Trujillo: Cerro Cabras, declive del cerro, 400 m.s.m. herbacea, flores amarillas. Aug. 6, 1949. N.Angulo 1219 (Holotype, NY).

The type locality of *Philoglossa purpureodisca* is within the area where *P. pterocarpa* might be expected to occur.

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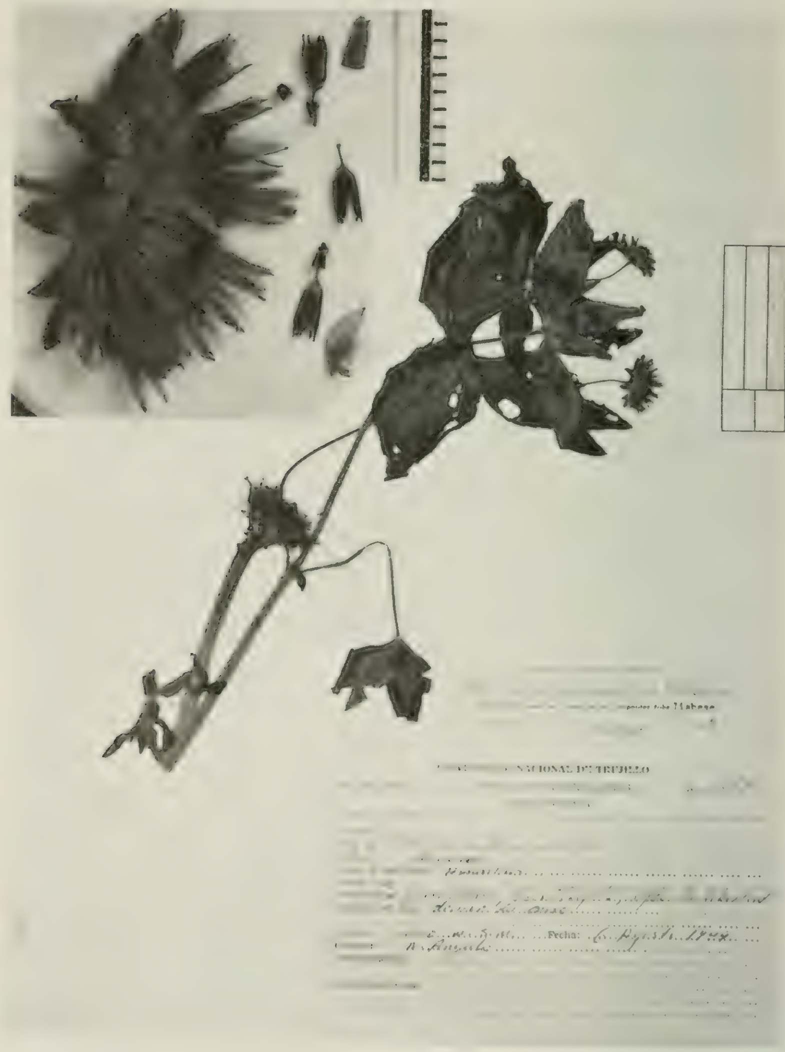

Philoglossa purpureodisca H.Robinson, Holotype, New York Botanical Garden. Photo by Victor E. Krantz, Staff Photographer, National Museum of Natural History.

STUDIES IN THE EUPATORIEAE (ASTERACEAE). CLIX. ADDITIONS TO THE GENUS, AYAPANA.

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The genus *Ayapana* was resurrected six years ago (King & Robinson, 1970) for a series of distinctive species having fimbriate style appendages and enlarged cells on the base of the carpopodium. A few corrections and additions have been made since (King & Robinson, 1970; 1973; 1975).

Recent collections from Ecuador and accumulated undetermined specimens of *Ayapana* from Colombia, Peru and Bolivia have been reviewed and the following three undescribed species and one species needing transfer have been encountered. All the new species have white flowers and blunt oblong phyllaries mostly glabrous in the basal half which relate them to the *A. elata* complex. The newly combined species seems to belong to this complex also. Because of the complexity of the genus a key to species is offered at the end of the paper.

Ayapana ecuadorensis R.M.King & H.Robinson, sp. nov. Plantae herbaceae usque ad 4 m altae laxe ramosae. Caules flavo-virides teretes striati dense puberuli. Folia opposita, petiolis non alatis 1.0-1.5 cm longis; laminae ovatae vel lanceolatae plerumque 6-9 cm longae 1.5-4.0 cm latae base acuminatae fere ad basem distincte trinervatae margine remote serrulatae vel subintegrae apice longe anguste acuminatae supra glabrae subtus glandulo-punctatae in nervis et nervulis puberulae. Inflorescentae paniculatae ca. 40 cm altae et latae, pedicellis plerumque 2-5 mm longis minute puberulis; capitula ca. 5 mm alta; squamae involucri ca. 25 ca. 4-seriatae exteriores ovatae 1.0-1.5 mm longae 1 mm latae extus dense puberulae, interiores usque ad 4 mm longae 0.5-1.0 mm latae oblongae vel anguste oblongae bistriatae obtusae vel truncatae extus plerumque glabrae ad apicem dense puberulae; flores 20-25 in capitulo; corollae albae? 3 mm longae superne sensim anguste infundibulares, lobis 0.2 mm longis 0.25 mm latis extus dense glanduliferis pauce breviter setiferis; filamenta in parte superiore ca. 0.15 mm longa; thecae ca. 0.7 mm longae; appendices antherarum oblongae 0.2 mm longae et 0.13 mm latae; appendices stylorum sensim parum angustiores; achaenia 1.3-1.5 mm longa superne setifera et perpauce glandulifera inferne minute spiculifera ad basem pauce gland-

ulifera; setae pappi 35-40 ca. 2.5 mm longae. Grana pollinis ca. 20μ in diametro.

Type: ECUADOR: Canar: along the road to Canar, ca. 77 kms ESE of Guayaquil. Elevation ca. 900 ft. Jan. 22, 1976. King & Garvey 6872 (Holotype US, Isotype MO). Paratype: ECUADOR: Canar: along the road to Canar, ca. 24 kms ESE of El Triunfo. Elevation ca. 1,000 ft. King & Garvey 7000 (US, MO).

The new species is most distinct in the form of the leaf which is trinervate from near the basal fifth and which is strongly acuminate. The species seems to be the only member of the white flowered group known in Ecuador but A. elata is known from Panama and the Choco to the north and from Peru to the south. The lack of previous collections of this species indicates the inadequacy of collecting in the lower elevations in Ecuador.

Ayapana haughtii R.M.King & H.Robinson, sp. nov. Plantae herbaceae 1.0-1.5 m altae laxe ramosae. Caules virides teretes striati glabrescentes. Folia opposita, petiolis non alatis 1-3 cm longis; laminae ellipticae primariae 15-17 cm longae et 3.0-3.5 cm latae base anguste acuminatae margine distincte remote serratae apice anguste acutae vel acuminatae supra glabrae subtus glandulo-punctatae et in nervis et nervulis puberulae, nervis secundariis pinnatis utrinque 5-6 sensim valde ascendentibus, folia secundaria 7-12 cm longa obscure serrata vel subintegra. Inflorescentiae paniculatae ca. 40 cm altae et 28 cm latae, ramis et ramulis minute puberulis, ramis laxe subcymosis, pedicellis saepe 5-7 mm longis; capitula ca. 5 mm alta; squamae involucre ca. 30 ca. 4-seriatae exteriores ovatae 1.0-1.5 mm longae et 0.5-0.8 mm latae obtusae extus puberulae, interiores usque ad 4 mm longae 0.7-1.0 mm latae oblongae vel anguste oblongae bistriatae obtusae vel truncatae extus plerumque glabrae ad apicem dense puberulae et glanduliferae; flores ca. 24 in capitulo; corollae albae? 3 mm longae superne sensim anguste infundibulares, lobis 0.2 mm longis et 0.3 mm latis extus dense glanduliferis perpauce setiferis; filamenta in parte superiore ca. 0.15 mm longa; thecae ca. 0.8 mm longae; appendices antherarum oblongae ca. 0.15 mm longae et 0.13 mm latae; appendices stylorum sensim angustiores; achaenia 1.3-1.5 mm longa superne setifera inferne sparse spiculifera perpauce glandulfera; setae pappi 35-40 ca. 2.5-2.8 mm

longae. Grana pollinis ca. 20-22μ in diametro.

Type: COLOMBIA: Sur de Santander: Vicinity of Puerto Berrio, between Carare and Magdalena Rivers, at Puerto Parra, on the Carare River at about 100 m. July 31, 1936. Haught 1972 (Holotype US, Isotype NY).

The unwinged leaf base and the 20-25 flowers per head relate the species most closely to *A. trinitensis* (Kuntze) K.& R. found in Trinidad and Venezuela and known from one collection in Colombia. The new species is distinct in the much more diffuse inflorescence with many long-pedicelled heads and by the elliptical often narrow rather than ovate leaves.

Ayapana lanceolata R.M.King & H.Robinson, sp. nov. Plantae scandentes usque ad 3.5 m longae laxe ramosae. Caules sensim castanei teretes vix striati minute puberuli. Folia opposita, petiolis non alatis 3-9 mm longis; laminae ovato-lanceolatae plerumque 8-13 cm longae et 3.5-5.0 cm latae base rotundatae vel subcordatae margine integrae apice anguste acuminatae supra glabrae, nervis et nevulis prominulis, subtus dense glandulo-punctatae in nervis minute puberulae, nervis secundariis pinnatis utrinque 5-6 plerumque in dimidio inferiores; folia superiora subtrinervata. Inflorescentiae paniculatae usque ad 40 cm altae et 35 cm latae, ramis cymosis, ramis et ramulis minute puberulis, pedicellis plerumque 1-2 mm longis; capitula ca. 6 mm alta; squamae involucri ca. 30 ca. 5-seriatae ovatae vel anguste oblongae 1-5 mm longae et 0.8-1.0 mm latae obtusae vel truncatae plerumque 4-striatae extus plerumque glabrae ad apicem dense puberulae et glanduliferae; flores ca. 24 in capitulo; corollae albae? ca. 3.5 mm longae anguste infundibulares, lobis 0.3 mm longis et latis extus dense glanduliferis; filamenta in parte superiore 1.0-1.5 mm longa; thecae 0.8-1.0 mm longae; appendices antherarum triangulares 0.20-0.25 mm longae et 0.13-0.15 mm latae; appendices stylorum sensim angustiores; achaenia ca. 2 mm longa in costis spiculifera ad apicem pauce glandulifera; setae pappi 30-35 ca. 2.5-2.8 mm longae. Grana pollinis ca. 18-20μ in diametro.

Type: PERU: San Martin: Prov. & Dist. Lamas, north of San Antonio 2-4 km, along Río Cumbasa in dense jungle. Alt. ca. 1200 ft. Vine to 10 feet; flowers probably white. Oct. 2- Nov. 4, 1937. Belshaw 3517 (Holotype US). Paratypes: PERU: Madre de Dios: Río

Acre. Seringal Auristella. Bl. grünlich gelbweiss, Kletterpfl. August 1911. Ule 9895 (US). BOLIVIA: La Paz: Region tropical, San Carlos b. Mapiri, 750 m, in Gebüsch, Strauch 1 m hoch. August 1907. Buchtien 1507 (US); Prov. of S. Yungas, basin of Rio Bopi, San Bartolome (near Calisaya), alt. 750-900 m. Herb. July 1-22, 1939. Krukoff 10353 (US).

The species is immediately distinct by the ovate lanceolate short-petioled leaves with rounded to slightly cordate bases. The under surfaces of the leaves appear brownish from the numerous glandular punctations. The corollas differ in shape significantly from those of *A. elata*, *A. ecuadorensis*, *A. haughtii*, and others of the white flowered group which flare abruptly near the apex and have lobes broader than long. In the new species the corolla is a more conventional funnelform and the lobes are as long as broad. The Bolivian material is very immature and differs in minor ways from the type from north-central Peru. The Ule specimen is in poor vegetative condition but is mature showing all the characteristics of the species. The latter is from an area of Peru adjacent to Bolivia. The species seems to have a considerable range along the edge of the Amazon Basin.

Ayapana pilluanensis (Hieron.) R.M.King & H.Robinson, *comb. nov.* *Eupatorium pilluanense* Hieron., Verh. Bot. Ver. Brand. 1906. 48: 201. (1907). The species is placed here on the basis of the description and a photograph of the type specimen (B-destroyed). The species was originally compared with *Eupatorium* (*Condylidium*) *iresinoides* (HBK) by Hieronymous, and the plant in the photo shows the habit shared by *Ayapana* and *Condylidium*. Nevertheless, the photo also shows the corolla shape and the involucre well enough to exclude *Condylidium* from consideration.

Key to Species

1. Heads with paleae; pappus reduced to short fringe ..... *A. squarrosa*

1. Heads without paleae; pappus with 20-40 capillary bristles 2

2. Heads slightly to strongly reddish; phyllaries acute to acuminate, phyllaries pubescent over most of outer surface 3

2. Heads not reddish, corollas white; phyllaries obtuse or rounded to truncate, inner phyllaries glabrous except at tips 7

3. Phyllaries in 4-5 graduated series, outer phyllaries mostly oblong 4

3. Phyllaries in 2-4 indistinct series, all phyllaries linear-lanceolate 5

4. Leaves perfoliate with broadly winged petioles; heads with ca. 22 flowers *A. ornithophora*

4. Leaves with very short unwinged petioles; heads with 30-40 flowers *A. amygdalina*

5. Heads with ca. 25 flowers; inflorescence with densely subcorymbose branches; leaves pinnately veined *A. stenolepis*

5. Heads with 30-55 flowers; inflorescence with laxly cymose branches; leaves trinervate 6

6. Stems and often midveins of leaves becoming reddish; upper surfaces of leaves glabrous *A. triplinervis*

6. Stems and midveins of leaves not reddish; upper surfaces of leaves pilose *A. jaramillii*

7. Leaves short-acute *A. pilluanensis*

7. Leaves sharply acute to acuminate 8

8. Leaves sessile or with distinct narrow wing to base, often with stipule-like auricles 9

8. Leaves petiolate without evident wings 11

9. Leaves narrowly lanceolate, without hairs below *A. hylophila*

9. Leaves narrowly lanceolate to ovate, with hairs below on at least the veins 10

10. Branches of inflorescence laxly cymose *A. elata*

10. Branches of inflorescence densely subcymose to corymbose *A. turbacensis*

11. Leaves trinervate from near base — _A. ecuadorensis_

11. Leaves pinnately veined — 12

12. Heads with ca. 12 flowers; leaf tips strongly and narrowly acuminate — _A. tovarensis_

12. Heads with 20-25 flowers; leaf tips usually only slightly acuminate — 13

13. Leaves with rounded or cordate bases; plants of Peru and Bolivia — _A. lanceolata_

13. Leaves with cuneate bases; plants of Colombia and Venezuela — 14

14. Inflorescence diffuse without contiguous heads; leaves elliptical to narrowly elliptical — _A. haughtii_

14. Inflorescence with heads in clusters; leaves mostly ovate — _A. trinitensis_

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Acknowledgement

This study was supported in part by the National Science Foundation Grant BMS 70-00537 to the senior author.

Ayapana ecuadorensis R.M.King & H.Robinson, Holotype, United States National Herbarium. Photo by Victor E. Krantz, Staff Photographer, National Museum of Natural History.

Ayapana haughtii R.M.King & H.Robinson, Holotype, United States National Herbarium.

Ayapana lanceolata R.M.King & H.Robinson, Holotype, United States National Herbarium.

Enlargements of heads of _Ayapana_. Top left, _A_. _ecuadorensis_. Top right, _A_. _haughtii_. Bottom, _A_. _lanceolata_.

A NEW SPECIES OF TAXILEJEUNEA FROM VENEZUELA

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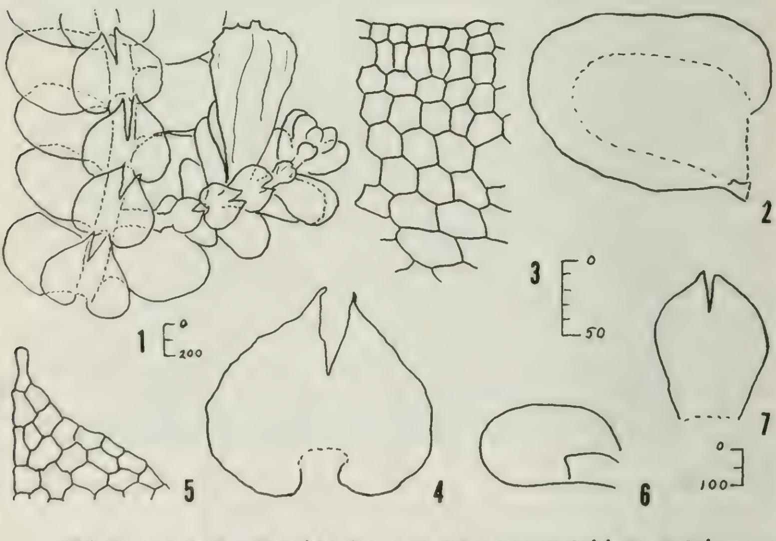
Three recent collections by Dr. Julian Steyermark from the State of Yaracuy in Venezuela represent a distinctive and previously undescribed species of Taxilejeunea. The generic assignment is made mostly on the basis of the large cordate underleaves and the lateral perianths with single innovations. This generic position is strengthened by the occasional presence of a second perianth on the innovations. The species is one of the few forms in the genus having broadly rounded leaf tips and is distinct among these by the marked vitta of enlarged central cells in the leaves surrounded by smaller cells. The near lack of lobuli combined with the oblong sharply spreading leaves gives the plant a superficial resemblance to some tropical american species of Calypogeia such as C. parallelogramma (Spruce) Steph.

Taxilejeunea steyermarkii H.Robinson, sp. nov.

Plantae autoicae pusilla flavo-virides, vittis foliorum flavescentiores. Caulis veteriores profuse ramosi ex 7 cellularum corticalium et 17-18 medullarium seriebus compositus. Folia caulina contigua recte patula plano-disticha oblonga ca. 700µ longa et 500µ lata base superiore subcordata apice late rotundata margins vix crenulata; cellulae interiores in vittis latis ovales vel oblongae 40-50µ longae et 20-25µ latae, parietibus subdistincte minute noduliferis, trigonis minutis distinctis; cellulae versus marginem subabrupte differentes rotundatae vel subquadratae marginales ca. 15µ diam. submarginales ca. 20µ diam., parietibus inornatis; parietes exteriores omnes asperulae?. Amphigastria late ovata vel suborbiculata caule 3-4-plo latiora plerumque 450-600µ longa et lata base late cordata ad medium bifida, lobis valde acuminatis, cellulis basilaribus ad 35µ diam., mediis oblongis vel subrotundatis 15-25µ latis et 25-30µ longis, cellulis versus marginem sensim subrotundatis vel subquadratis 15-20µ diam., cellulis apicalibus cylindraceis, trigonis in partibus mediis minutis, parietes exteriores non asperulae. Perianthia in ramulis terminalia, innovationibus unicis raro denuo

fertilibus. Folia floralis spathulata ca. 400μ longa et 200μ lata apice rotundata, cellulis ad cellulam foliorum caulinarum similibus, lobulis oblongis ca. 150μ longis et 70μ latis breviter acutis; bracteola obovata 350-400μ longa ad 1/3 bifida, lobis breviter acuminatis, cellulis irregularibus 15-35μ longis et 12-25μ latis versus marginem minimis. Perianthia obpyriformia ca. 400μ longa et 200μ lata aliquantum complanata inferne nuda superne in carinis pauce denticulata. Androecia in ramulis brevibus terminalia.

Type: VENEZUELA: Yaracuy: Selva nublada, El Ampato, 7-11 km al norte de Salom, Distrito Nirgua. Altura: 1200-1300 m, on living branch by stream. Mar. 22, 1975. Steyermark & Carreno Espinoza 111484a (Holotype US; isotype VEN). Paratypes: VENEZUELA: Yaracuy: same data as holotype except epiphyllous. Steyermark & Carreno Espinoza 111470a (US, VEN); Yaracuy: Cabeceras de la Quebrada Amparo, selva nublada virgen en la cumbre, El Amparo hacia Candelaria, a 7-9 km al norte de Salom. altura 1220-1250 m, epiphyte. Nov. 30, 1974. Steyermark & Carreno Espinoza 111178a (US, VEN).



Figures 1-7. Taxilejeunea steyermarkii H.Robinson. 1. Part of plant with female branch. 2. Cauline leaf. 3. Cells of median upper sector of leaf. 4. Underleaf. 5. Cells of lobe apex. 6. Female floral leaf with lobule. 7. Female bracteole.

WEEDS (?) OF JAPAN
Otto & Isa Degener

A mysterious package arrived by certified mail recently from the Kumiai Chemical Industry Co., Ltd. It contained a brochure and a heavy 2.5 cm., thick book measuring 19 X 26 cm. The imposing brochure shows this Tokyo concern to have a paid-up capitalization of 1,260,000,000 yen, and to have branch factories in Sao Paulo, Brazil and Bangkok, Thailand. The company concentrates in the manufacture of pesticides, industrial chemicals, veterinary medicines and feed additives. Colored photographs show some of these activities. The preoccupation with herbicides and other chemicals of agricultural importance, we assume, induced financing the writing and publication of the accompanying book: Weed Flora of Japan Illustrated by Colour, "edited by: Makoto Numata and Nagato Yoshizawa" and "planned by: The Japanese Association for Advancement of Phyto-Regulation (JAPR)." Would that America's larger industrial firms emulated those of Japan by advertising their products through works of permanent, scientific value.

This Flora of 515 pages, published last August on filled stock, sells for $40. Though printed mostly in Japanese, the vernacular and scientific names of plants, their distribution in Japan and elsewhere, and the phenology are likewise printed in English. Moreover, pictures can be "read" in any language; and here the work is of outstanding help for the foreigner. In the taxonomic part of the volume there are 826 colored photographs measuring 5 X 7 cm., some consisting of two separate prints showing a plant in two separate stages of growth. Besides these, there are 557 accompanying figures in black and white carefully drawn to show not only a habit sketch; but also details of roots, rhizomes, ocreae, ligules, flowers, fruits, seeds and spores. Of 556 taxa listed in the index, practically all are described and figured. They belong to 331 genera, and of these genera more than two thirds are described and figured in Britton & Brown's "Flora." How many of the species are identical with those in the area covered by the latter work, the reader can check for himself.

A few trivial imperfections were noted, such as not using the orthography "Sigesbeckia" on page 229, showing a photograph upside down on page 290, and listing a few plant names on pages 412 and 413 of the index in alphabetical disorder. The great fault we find is that the authors and the sponsoring chemical company are far too modest in their claims. Numata & Yoshizawa's volume is not a "Weed Flora of Japan" at all! Too many of the plants are lovely and interesting ones gracing fields, marshes and roadsides. To us a more appropriate title would have been "Herbaceous Flora of Japan, Illustrated in Colour." Were we to tour Japan again, we would include this book in our 'plane luggage in spite of its weight.

ADDITIONAL NOTES ON THE GENUS <u>AVICENNIA</u>. VIII

Harold N. Moldenke

AVICENNIA L.

Additional synonymy: <u>Avicenina</u> L. ex Alston in Trimen, Handb. Fl. Ceylon 6: Suppl. 233, sphalm. 1931. <u>Trepanocarpus</u> Mart., in herb.

Additional & emended bibliography: Forst. f., Pl. Escul. Ins. Ocean. Austr. 72. 1786; Forst. f., Fl. Ins. Austr. Prod. 45. 1786; W. Griff., Notul. Pl. Asiat. 4: 185—195. 1854; Beddome, Fl. Sylv. Anal. Gen. 174, pl. 22, fig. 2. 1872; Bocq.-Lim., Palét. Mangl. 31 & 114—121. 1911; E. D. Merr., Fl. Manila, imp. 1, 397. 1912; Annal. Mus. Colon. Marseille, ser. 4, 4: 2, pl. 64. 1926; Mém. Acad. Malgache 5: pl. 20, fig. 56. 1927; Bull. Imp. Inst. Lond. 37: 336. 1939; Pilgrim, Indian Forest Leafl. 72: 5. 1944; Sonohara, Tawada, & Amano [ed. E. H. Walker], Fl. Okin. 131. 1952; Santapau, Bull. Bot. Surv. India 8: 37, 40, & 291. 1966; E. D. Merr., Fl. Manila , imp. 2, 397. 1968; Bolkh., Grif, Matvej., & Zakhar.,Chrom. Numb. Flow. Pl., imp. 1, 714. 1969; Tan & Keng, Journ. Singapore Nat. Acad. Sci. 1: 8—29. 1969; G. W. Thomas, Tex. Pl. Ecolog. Summ. 77. 1969; V. J. Chapm., Salt Marshes & Salt Des., ed. 2, xvi, 212, 229, 233, 234, & 374, pl. 34b. 1973; Bolkh., Grif, Matvej., & Zakhar., Chrom. Numb. Flow. Pl., imp. 2, 714. 1974; R. W. Long, Fla. Sci. 37: 41. 1974; Mapp-Zinn, Anat. Blat. 153, 160, 244, 283, 394, 434, 632, 658, 1079, 1092, & 1326. 1974; Gunn & Dennis, World Guide Trop. Drift Seeds 78, 79, 210, & 216, fig. 23. 1976; Moldenke, Phytologia 33: 238—270, 507, & 510. 1976; Norman, Fla. Scientist 39: 20 & 30. 1976; Raven, Evert, & Curtis, Biol. Pl., ed. 2, 427 & 670, fig. 210-12. 1976; E. H. Walker, Fl. Okin. & South. Ryuk. 895—896, pl. 18. 1976.

It should be noted here that knee-roots are reported for <u>Avicennia</u> (<u>A. marina</u>) in Tanzania by McCusker (1971), that the so-called "river mangrove" of Africa is <u>Aegiceras</u> <u>corniculatum</u>, and that Walker (1976) is now also among the long list of taxonomists to accept the <u>Avicenniaceae</u> as a valid family, giving "Hirugi-damashi zoku" as the vernacular name for the genus in Okinawa and the southern Ryukyu Islands.

AVICENNIA ALBA Blume

Additional & emended bibliography: Santapau, Bull. Bot. Surv. India 8: 37 & 291. 1966; Bolkh., Grif, Matvej., & Zakhar., Chrom. Numb. Flow. Pl., imp. 1, 714. 1969; Corner & Watanabe, Illustr. Guide Trop. Pl. 750 & 751. 1969; Tan & Keng, Journ. Singapore Nat. Acad. Sci. 1: 8—29. 1969; Bolkh., Grif, Matvej., & Zakhar., Chrom. Numb. Flow. Pl., imp. 2, 714. 1974; Moldenke, Phytologia 33: 239—241 & 260. 1976.

Conn & Katik describe this tree as to 20 m. tall, the bole 6

m. tall, the trunk diameter 45 cm. at breast height, the bark dark-brown, the sapwood cream, and the leaves dark-green above and pale-green beneath. They encountered it in coastal swamps, on "sandy grey-black soil due to accumulation of litter".

The corollas on Soepadmo & Mahmd KLU.9158 are said to have been "greenish-yellow" when fresh, and these collectors describe the plant as a tree, 15 m. tall, the trunk 20 cm. in diameter, and found it growing in a "disturbed" mangrove forest. The Kasim bin Rajab s.n. [12.10.1963] collection, cited below, consists only of very small seedlings.

The Khoo & Ming N/K.069, Mahmud s.n. [May 1970], Poore 123, Poore & Kassim 335, B. C. Stone 5931 & s.n. [Dec. 1967], and Stone & Halle 11032, distributed as typical A. alba, actually represent var. latifolia Moldenke.

Additional citations: MALAYA: Selangor: Kasim bin Rajab 102 (Kl—1102), s.n. [12.10.1963] (Kl—1792). Trengganu: Soepadmo & Mahmd KLU.9158 (Kl—12954). GREATER SUNDA ISLANDS: Sarawak: Carrick & Enoch JC.422 (Kl—3397). Sebatik: Tanglon A.1582 (Kl). NEW GUINEA: Papua: Conn & Katik LAE.66065 (Mu).

AVICENNIA ALBA var. LATIFOLIA Moldenke

Additional bibliography: Moldenke, Phytologia 32: 453. 1975.

Recent collectors describe this plant as a common small tree, 6—8 m. tall, with short stilt-roots [Khoo & Ming N/K.069] and erect pneumatophores, the trunk 10—15 cm. in diameter, the bark smooth, not fissured, and the leaves long and pointed, white beneath. The corollas are said to have been "greenish-yellow" on Soepadmo KLU.9162 and "orange" on Khoo & Ming N/K.069. It has been found growing in mangrove swamps from sealevel to 5 m. altitude, flowering in May, July, and August, in fruit in February, July, and September.

Material of this variety has been misidentified and distributed in some herbaria under the name, A. intermedia Griff.

Additional citations: MALAYA: Selangor: Khoo & Ming N/K.069 (Kl—8636); Mahmud s.n. [May 1970] (Kl—13368); Poore 123 (Kl—123); Poore & Kassim 335 (Kl—1335); B. C. Stone 5931 (Kl—5613), s.n. [Dec. 1967] (Kl—8561); Stone & Halle 11032 (Kl—17081). Trengganu: Soepadmo KLU.9162 (Kl—12958).

AVICENNIA ELLIPTICA Holm

Additional synonymy: Trepanocarpus inundatus Mart., in herb.

Additional bibliography: Moldenke, Phytologia 32: 438 & 454—455 (1975) and 33: 255, 256, 262, 268, & 269. 1976.

AVICENNIA EUCALYPTIFOLIA Zipp.

Additional & emended bibliography: Mukherjee & Chanda, Geophyt. 3: 86 & 88, text fig. 1 & pl. 1, fig. 2. 1973; Moldenke, Phytologia 33: 240—241. 1976.

Material of this species is sometimes misidentified and distrib-

uted in some herbaria under the designation, A. marina var. australasica (Walp.) Moldenke

Additional citations: GREAT BARRIER REEF: Bewick: Thom 4163 (N).

AVICENNIA GERMINANS (L.) L.

Additional synonymy: Avicennia tomentosa Weigelt ex Moldenke, Fifth Summ. 1: 394, in syn. 1971 [not A. tomentosa Blanco, 1845, nor Blume, 1918, nor R. Br., 1851, nor L., 1826, nor Roxb., 1835, nor Schau., 1940, nor "sensu Marc.", 1971, nor "sensu Mayc.", 1965, nor Sieber, 1944 (in part), nor Vahl, 1921, nor Wall., 1851].

Additional bibliography: Wangerin in Just, Bot. Jahresber. 50 (1): 44. 1929; G. W. Thomas, Tex. Pl. Ecolog. Summ. 77. 1969; R. W. Long, Fla. Sci. 37: 41. 1974; Gunn & Dennis, World Guide Trop. Drift Seeds 78, 79, 210, & 216, fig. 23. 1976; Moldenke, Phytologia 33: 238 & 241--270. 1976; Norman, Fla. Scientist 39: 20 & 30. 1976; Raven, Evert, & Curtis, Biol. Pl., ed. 2, 427 & 670, fig. 20-12. 1976.

Additional illustrations: Gunn & Dennis, World Guide Trop. Drift Seeds 79, fig. 23. 1976; Raven, Evert, & Curtis, Biol. Pl., ed. 2, 427, fig. 20-12. 1976.

The corollas are said to have been "white" on Breedlove & Thorne 20806, D. S. Correll 46449, and Plowman 3540. In addition to months previously reported in these notes, it has been found in anthesis in December.

Pételot (1953) gives a lengthy and detailed description of the medicinal uses of what purports to be this species (although he mis-applies it to A. officinalis L.) in Cuba, Mexico, Guadeloupe, and French Guiana. Especially interesting is his description of its use in the treatment of leprosy. "Les Docteurs Mathias Duque et Moreno, de Cuba, ont employé le médicament sous forme d'extrait fluide ou d'extrait mou. Prendre matin et soir une cuillerée à café d'extrait fluide en augmentant la dose jusqu'à ce qu'on arrive à huit, dix ou douse cuillerées à café par jour. Pour l'extrait mou, il est administré en pilules ou en solution concentrée, la dose maxima est de 6 à 8 grammes par jour. Ce traitement est généralement très bien toléré et donne rarement lieu à des nausées, des vomissements ou des douleurs intestinales.

"Localement, on applique sur les ulcères de la lèpre des compresses imbibées d'une solution aqueuse de 50 percent d'extrait fluide. Il est également utile de faire prendre au malade tous les soirs, avant le coucher, un bain de température de 39° à 49° et de 15 à 20 minutes de durée, que l'on additionne d'une décoction d'écorce de Palétuvier en quantité suffisante pour colorer en rouge l'eau du bain.

"Bocquillon préconise, une fois par jour, un verre à bordeux de vin de Palétuvier, fait avec du vin rouge dans la proportion du vin quinquina du Codex.

"Sous l'influence de ce traitement, l'amélioration apparaît en général au bout de 15 à 20 jours, l'appétit et le sommeil renais-

sent et les névralgies deviennent moins intenses.

"Le mois suivant, les taches violacées de la peau prennent une teinte rosée et pâlissent, notamment à la périphérie, et des espaces de peau saine reparaissent là où étaient des macules confluentes.

"En même temps, les ulcérations suppurent avec moins d'abondance et la cicatrisation est complète vers le huitième mois. La sensibilité commence à se rétablir au quatrième mois, lorsque toutefois la conservation du nerf en permet le retour.

"Ces résultats sont variables, naturellement selon la phase à laquelle est arrivé le mal au moment où le traitement a commencé. C'est ainsi que, dans tous les cas de lèpre à la période du début où les Docteurs Duque et Moreno ont en recours au Palétuvier, la guérison a eu lieu dans l'espace de 8 à 10 mois. Parmi les malades ayant atteint la période d'état, mais avec envahissement nul ou à peine marqué des viscères, 60 percent auraient été guéris dans un espace de temps de 2 à 5 ans, et en moitié moins de temps on aurait obtenu la guérison sociale. Les stigmates de la lèpre n'étaient plus apparents et la malade n'offrait plus de danger de contagion pour l'entourage. Enfin, lorsque la lèpre est parvenue à la troisième période, le Palétuvier n'a plus d'action sur les névrites ni sur les troubles trophiques, mais il est susceptible d'amener une amélioration notable: disparition de la diarrhée et de la fièvre et augmentation du poids du corps.

"Des expériences de contrôle établies à la léproseries de la Havane ont confirmé la guérison dans quelques cas, l'amelioration se serait manifestée très souvent; toutefois, on ne saurait indiquer le Palétuvier comme un médicament spécifique absolu de la lèpre."

In Guiana, he says, "La lépre s'y étendait d'une façon fâcheuse et il était grand temps d'enrayer le fléau. Les résultats obtenus furent satisfaisants et nous ferons connaître plus tard les résultats obtenus d'une façon méthodique." He further remarks that the work of 146 pages by Mathias Duque, published in 1905, confuses Rhizophora mangle with Avicennia: "ce sont là des sujets très différents".

Gunn & Dennis (1976), in speaking of Avicennia germinans, assert that it is disseminated by the "Seedling, sprouted fruit, or rarely unsprouted fruit.....Seedling....up to 12 cm long with a conspicuous hairy root and 2 greenish cotyledons. Sprouted fruit.. up to 5 cm long, 2.5 cm wide, oblong to elliptical, compressed in cross section, dark brown, smooth (hairy when fresh), bearing a protruding hairy root. Unsprouted fruit....similar but lacking the protruding root." They say that the "Unfolded cotyledons are said to serve as miniature boats, but this does not explain how germinating and non-germinating fruits float. It would appear that buoyancy is due to buoyant seedling or fruit tissues." They further assert that buoyancy lasts about a year and that nearly 100 percent of the seedlings are viable.

These authors further comment that "Unlike most dissemimules, the black mangrove usually drifts as seedlings, not as seeds or

fruits. The fruit acts as a surrogate seed coat, because the seed coat is absent. The embryo germinates while the fruit is still attached to the parent tree. When the seedling drops, it may be self-planted in the mud below the parent tree, or be carried out into the ocean by the tide. Black mangroves are frequent to common members of the tidal swamps along the tropic and subtropic coasts of the New World and west Africa. Black mangrove was introduced into west Africa by man. While the red mangrove (Rhizophora mangle) and its relatives have rugged appearing drift seedlings, black mangrove seedlings appear to be so delicate that they would not be able to withstand the vicissitudes of drifting or being stranded. Black mangrove disseminules are amazingly hardy, as Guppy (1917) discovered when he dried some mature fruits for 25 days at room temperature. The fruits lost 50 percent of their weight during the drying process. Yet they germinated when placed in fresh water. In our buoyancy tests, the fruits and seedlings often become soft and rotted, indicating that not all of them are as seaworthy as disseminules protected by a bony fruit or seed wall. Other common names for the black mangrove include salt-bush, because salt crystals are often gathered from the leaves, and honey mangrove, because of the excellent honey made from the floral nectar."

It should be stated here that I have found absolutely no evidence thus far in literature or elsewhere to substantiate the above claim that Avicennia was introduced from America to west Africa by man. I regard the west African population as A. africana P. Beauv., related to but distinct from A. germinans (L.) L., most similar to forms of A. germinans var. guayaquilensis (H.B.K.) Moldenke and A. tonduzii Moldenke.

The D. H. Knight 1032 and J. A. Steyermark 62900, previously regarded by me as typical A. germinans, seem better placed as var. guayaquilensis (H.B.K.) Moldenke although strongly resembling the typical form.

Additional & emended citations: MEXICO: Chiapas: Breedlove & Thorne 20806 (N). CAMPECHE BANK: Alacran: F. R. Fosberg 41866 (N, W—2430910), 41904 (W—2430969). JAMAICA: "J. C." S.54 (Kl—7426). TURKS AND CAICOS ISLANDS: Providenciales: D. S. Correll 46449 (N). COLOMBIAN CARIBBEAN ISLANDS: San Andres: A. Gentry s.n. [August 4, 1967] (Ws). COLOMBIA: Atlántico: Plowman 3540 (N). Chocó: Duke 9703 (Oh). Guajira: Romero-Castañeda 4496 (Ac). Magdalena: Romero-Castañeda 7275 (Ac). VENEZUELA: Carabobo: Robertson & Austin 213 (Ld). Delta Amacuro: Budowski 98a-18 (Gz, N), 118-18 (Gz, Kh, N), 2032-19 (Kh, N). Zulia: Budowski 25 (Ac, Gz, N); H. M. Curran 250 (N), 252 (N), 252a (N), 254 (Ac, Gz, Kh, N). Baira Island: Budowski 96-28 (N). SURINAM: Hostman 1140 (Pd). ECUADOR: Esmeraldas: Harling 1696 (S); Sparre 18130 (S). GALAPAGOS ISLANDS: Indefatigable: L. A. Fournier 81 (Ac). Narborough: F. R. Fosberg 44703 (Ld).

AVICENNIA GERMINANS var. GUAYAQUILENSIS (H.B.K.) Moldenke

Additional bibliography: Moldenke, Phytologia 33: 249, 250, 255, 257, 259, 261, 262, & 267—270. 1976.

Steyermark encountered what appears to be this variety on sand dunes and flats of Sucre, Venezuela, although the leaves closely approximate those of typical A. germinans (L.) L.

Additional citations: VENEZUELA: Sucre: J. A. Steyermark 62900 (Mi, N). GALAPAGOS ISLANDS: Indefatigable: D. H. Knight 1032 (Ac, Ws).

AVICENNIA LANATA Ridl.

Additional synonymy: Avicennia officinalis δ spathulata Kuntze, Rev. Gen. Pl. 2: 502. 1891. Avicennia officinalis δ spathulata f. tomentosa Kuntze, Rev. Gen. Pl. 2: 502. 1891. Avicennia tomentosa Auct. ex Kuntze, Rev. Gen. Pl. 2: 502, in syn. 1891 [not A. tomentosa Blanco, 1845, nor Blume, 1918, nor R. Br., 1851, nor Jack, 1945, nor Jacq., 1760, nor L., 1826, nor L. & Jacq., 1783, nor G. F. W. Mey., 1818, nor Nutt., 1947, nor Nutt. & Br., 1832, nor Roxb., 1835, nor Schau., 1940, nor Sieber, 1844, nor Sw., 1864, nor Vahl, 1921, nor Wall., 1851, nor Weigelt, 1851, nor Willd., 1800, nor sensu Marc., 1965].

Additional bibliography: Ten & Keng, Journ. Singapore Nat. Acad. Sci. 1: 8—29. 1969; Moldenke, Phytologia 33: 270. 1976.

This species is based on Burkill & Watson 3793 & 3797 from Singapore and on Watson 2767 from Pahang. Burkill (1966) comments that this is the "largest of the Malayan species, attaining 100 feet in height, and commonly 70—80 feet. It grows gregariously on the east coast of the [Malay] Peninsula, and is found in Singapore, but not on the west coast."

It should be noted here that Burkill, in the work cited above, reduces to synonymy under A. lanata the A. marina var. rumphiana and A. officinalis, "of many authors". Whether he intends to include here the true A. marina var. rumphiana (H. Hallier) Bakh. or just that "of many authors", as he does the A. officinalis "of many authors, is not clear.

It should also be pointed out that the A. tomentosa of Blanco, referred to in the synonymy above, is a synonym of A. marina var. rumphiana (H. Hallier) Bakh., that of Blume is A. alba Blume, that of Brown and of Sieber (in part) is A. marina var. resinifera (Forst. f.) Bakh., that accredited to Jack, to Jacquin, to Linnaeus, to Linnaeus & Jacquin, to Meyer, to Nuttall, to Nuttall & Brown, to Sieber (in part), to Swartz, and to Weigelt is A. germinans (L.) L., that credited to Linnaeus, to Vahl, and to Wallich is A. marina (Forsk.) Vierh., that credited to Roxburgh and to Willdenow is A. officinalis L., and that credited to Schauer and to "sensu Marc." is A. schaueriana Stapf & Leechman.

Additional citations: MALAYA: Singapore: Gill 22 (Ft—9699).

AVICENNIA LANCEOLATA (Engelh.) Moldenke

Additional bibliography: Moldenke, Phytologia 14: 328. 1967; Moldenke, Fifth Summ. 1: 375 (1971) and 2: 531 & 839. 1971; Moldenke, Phytologia 32: 365. 1975.

AVICENNIA MARINA (Forsk.) Vierh.

Additional & emended synonymy: Racka torrida J. F. Gmel. in L., Syst. Nat. Veg. 2: 245. 1791. Avicennia officinalis γ ovatifolia Kuntze, Rev. Gen. Pl. 2: 502. 1891. Avicennia nitida Thunb. ex Alston in Trimen, Handb. Fl. Ceylon 6: Suppl. 233, in syn. 1931 [not A. nitida (Alter.) Sessé & Moç., 1956, nor Blanco, 1837, nor Jacq., 1760, nor L., 1960, nor L. & Jacq., 1783, nor Rodsch., 1844, nor Sessé & Moç., 1894]. Avicennia marina Vierh. apud Prain, Ind. Kew. Suppl. 4: 21. 1913. Avicennia mariana Vierh. ex Moldenke, Phytologia 7: 210, in syn. 1960. Avicennia racemosa Cornwell ex Moldenke, Phytologia 7: 210, in syn. 1960. Avicennia officinalis "sec. auct. afr." apud Dale & Greenway, Kenya Trees 581, in syn. 1961 [not A. officinalis Auct. ex Allen, 1961, nor Auct. ex Jafri, 1973, nor Blume, 1960, nor Kurz, 1885, nor L., 1753, nor (L.) Kurz, 1938, nor H. J. Lam, 1940, nor Millsp., 1930, nor Miq., 1918, nor Schau., 1856, nor Watt, 1958]. Avicennia maritima Naurois & Roux, Bull. Inst. Fond. Afr. Noire 27: 851, sphalm. 1965. Avicennia officinalis "L. sensu lat." apud Gaussen, Legris, & Viart, Ind. Counc. Agr. Res. Map Ser. 2: 16, in syn. 1965. Avicennia marina Forsk. ex Gaussen, Legris, & Viart, Ind. Counc. Agr. Res. Veg. Map Ser. 2: 16. 1965. Avicennia marina (Forst.) Vierh. apud J. M. Ward, Veget. Act. Geobot. 14: 247, sphalm. 1967. Avicennia marina (Forsk.) Vierk. apud Lewis & Naidoo, S. Afr. Journ. Sci. 66: 268, sphalm. 1970. Avicennia marina (G. Forst.) Vierh. apud Foreman, Div. Bot. Dept. For. N. Guin. Bot. Bull. 5: 63. 1972. Avicenna marina Cloudsley-Thomp., Terrestr. Environ. 36, sphalm. 1975. Avicennia marina L. ex Moldenke, Phytologia 28: 453, in syn. 1974.

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Recent collectors refer to this plant as a small and low or medium-sized tree or treelet, 1.3—23 m. tall, wide-spreading, and much-branched, or a shrub, 1.5—4 m. tall, dome-shaped, branching near the ground, growing singly or gregarious, sometimes growing beneath A. alba Blume or close to A. marina var. angustata Moldenke, often a crooked willow-like tree forming thickets, usually with very numerous, closely packed, slender, vertical, erect, root-processes ["rhizophores"] or pneumatophores, some as far as 6.5 m. from the trunk, or "stunted and without pneumatophores", rarely with prop-roots, the trunk to 14 cm. in diameter, with 5—36-inch girth, gray, the bole sometimes 2 feet in girth 10 feet above the ground, or shrubs with a 5-foot crown, the outer bark surface smooth and gray or reddish-brown to green, dark-green, yellowish-green, or light yellowish-green, sometimes grayish-green with thin pinkish-red papery flakes, the living bark green, the stems glaucous, the branches gray, with jointed leafless suckers, the sap colorless, the leaves light yellowish-green, acutely pointed, bicolored, paler or white beneath, the flower-buds green or greenish, the flowers aromatic and honey-scented with a slightly sourish-sweet odor, 4-merous, "rare" at the ends of the spreading lower branches, the calyx green, petals 4, stamens 4, alternating with the petals, exserted, the pistil yellow, and the fruit round [Maxwell 72-335], soft-tomentose, glaucous-green or dull-green, tinged yellowish or orange [Santos 5148] when ripe.

The corollas are said to have been "yellow" on Amaratunga 1830, Bernardi 11814, Cooray 69073011R, Fosberg 52048, Geesink & Santisuk 5230, Read 2172, Stoddart 1515, Tanner 2464, and Tirvengadum & Waas 465, "bright-yellow" on Fosberg 51242, "deep-yellow" according to Beard (1970), "yellow-orange" on Chai S.26762 & S. 26765, "orange-yellowish" on Chai S.27541, "orange-yellow" on Chai PC.2, S.22950, & S.29948, Fosberg 48675, Meijer 752, and Meijer & Balakrishnan 131, "orange" on Cooray 69092808R & 69100505R, Fosberg 37425, Gillis 8388, Maxwell 71-349, and Santos 4748, "dull-orange" on Amaratunga 110 and Simpson 9850, "yellow to orange" on Van der Kevie 2, and "bluish" on Pancho 2085.

Cooray, on the labels on one of his collections, states "tree 3 cm tall", but obviously this is a stenographic error for "3 m." since his specimens is not a seedling. Wood samples accompany Chai S.29950 in some herbaria. The tree represented by Winter

7713 is said to have been photographed by the collector.

Pollen of A. marina was studied by Mukherhee & Chanda (1973) on the basis of Bakhuizen 449 from Java in the Utrecht herbarium and has been described as "tricolporate; colpi ca. 25 mu x 5 mu (range 22—35 mu x 4—5.5 mu), with thin margin; ora lelongate, confined within the limits of the colpi, ca. 9 x 5 mu (range 5—12 mu x 3—6 mu); mean intercolporal distance 13 mu; amb convex; sexinal part of exine projected outward and devoid of any ornamentation; mean apocolpium diameter 11 mu; prolate-spheroidal to spheroidal, P/E ca. 32 x 31 mu (range 27.5—36 mu x 26.5—36 mu); exine 3.5 mu thick; sexine 2.5 mu thick, reticulate, intectate, muri simplibaculate, rarely duplibaculate, heterobrochate, lumina polygonal, dimensions gradually becoming smaller toward the aperture; bacula provided with distinct globular knob-like head; nexine 1 mu thick, tenuinexinous; NPC classification 345.

Fig. 1. Avicennia marina showing numerous air-roots on under side of leaning trunk. Rejang Mangrove Forest Reserve, Sarawak. Photograph courtesy of Paul Chai, Forest Botanist, Sarawak, 1975.

Huang (1972) describes the pollen as "Grains 3-colporate; subprolate to spheroidal; 28—37 x 24—30 mu; amb circular-lobate; aperture common type, ora transversally parallel; exine 2 mu thick; tectum with verrucate processes; sexine reticulate, with OL-pattern; nexine thinner than sexine" [on the basis of Chang 2229].

Recent collectors have encountered A. marina on sandy shores in and above the tidal level, in mixed mangrove forests, along riversides, on sand bars, rocky seashores, moist lagoon bunds, open beaches, saline flats alongside of brackish pools, in coppices, in disturbed former mangrove areas, on "firm sandy flats with very little mud at river-mouths", "on consolidated sandy mus", in "flat soft silty mud near banks in mangrove forests", in "brackish water at highwater line", or "in sand inundated at high tide on sand flats back of beach-rock exposures", at altitudes of sealevel to 15 meters, flowering from January to July, September, and October, and in fruit in January, March to July, and September. Wirter reports it "forming most of the central area of swamps"; Cooray found it "common" in Sri Lanka; Perdue & Kibuwa refer to it as "locally dominant with Rhizophora, Ceriops, and Bruguiera. In New Caledonia MacDaniels reports it "occasional on dry hillsides, alt. 15 m." — a remarkable find. In Sri Lanka, according to Grupe, it is "commonly scattered on dry sandy flats or locally abundant in moist shallow depressions just back of sandy beaches", while Fosberg and his associates report it occasional there "near shrub-belt well back from beach on sand flats". Chai reports it "common on open inundated beaches" in Selangor.

Shantz refers to A. marina as the "chief tree of semi-tidal flats". Williams found it in "less inundated sites" in Zanzibar. Van der Kevie found it to be "very common on moderately firm soils" in Thailand. Pancho refers to it as "a littoral species throughout the Philippines". Fosberg describes it as "common especially in periphery of wooded area in mangrove scrub forest" on Aldabra island, "flooded by spring tides", "infrequent on lagoon shore in mangrove swamp on sandy bottom" on Euphrates island, and "common generally especially on lagoon beach ridges in mosaic of halophytic vegetation on low sand islands" on Manauli island.

Amico & Bavazzano (1968) report the species from Zambesia, Mozambique. Worrell & Sourry (1967) assert that in Australia the pneumatophores it produces are called "cobblers' pegs" and that "Up-river [it is] often associated with the bushy 'river mangrove' (Aegiceras corniculatum). The roots on the seedling develop very rapidly to catch up with and maintain the upper growth" and, further, that it is "found along the whole of the Australian coast extending to the cool climates of southern Victoria" [actually these statements apply in major part to var. resinifera (Forst. f.) Bakh. rather than to true A. marina]. Rao & Mukherjee (1967) refer to A. marina as the "chief mangrove in [the] belt fringing low muddy shores" in Saurashtra, India.

McCusker (1971) reports the presence of knee-roots on A. marina in Tanzania and specimens in various stages of development

are described and illustrated: "They arise from horizontal roots in a manner similar to pneumatophores but anatomically they resemble horizontal roots. After re-entering the soil the knee-root reverts to a horizontal position and gives rise to further pneumatophores and anchoring roots. When seen above the soil they appear superficially similar to the knee- or elbow-shaped roots produced by Bruguiera and Ceriops. They emerge to a height of 6—8 cm. above the soil or approximately half the height of the surrounding pneumatophores."

It should be noted here that Bakhuizen (1921) recorded the presence of air-roots on Avicennia marina, saying: "As a curiosity let us further remark that there are sometimes to be found air-roots on Avicennia trunks (I saw this with the variety intermedia but possibly the same occurs with other species or varieties). These air-roots are very similar to the breathing-roots, except that their direction is not negative-geotropic, but on the

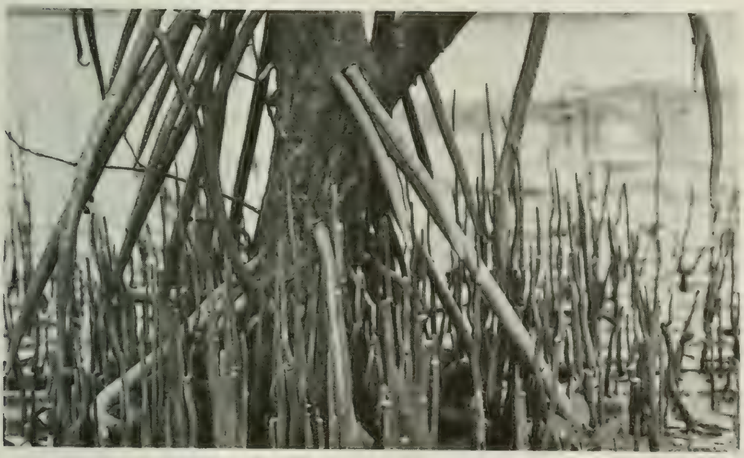

Fig. 2. Avicennia marina showing prop-roots and pneumatophores. Rejang Mangrove Forest Reserve, Sarawak. Photograph courtesy of Paul Chai, Forest Botanist, Sarawak. 1975

contrary they grow downwards. They occur along the stems up to a height of two meters, and if the trees are standing in a oblique position, one finds these roots on the lower side in a row close to each other. These air-roots remain short and thus do not reach the ground, but branch off. Within they are not spongy and fibrous like the breathing-roots, but ligneous. I mention this case for trees which stand on places where the marshes were filled up with sand, while the breathing-roots were more or less buried under the

ground. Probably this abnormal formation of air-roots was due to the breathing, which was prevented by the sand filling in the marsh."

Prop-roots were found by Chai on A. marina in Sarawak, as well as on A. alba Blume and on A. officinalis L., and air-roots on A. marina (see Fig. 1), but here occurring in areas where the pneumatophores were not sand-covered, as can easily be seen in the photographs (Fig. 1 & 2) very kindly sent to me by Paul Chai, Forest Botanist of Sarawak. He asserts that he has found trees with such prop-roots "to be confined to soft muddy soils".

Bakhuizen (1921) regards only the populations in East Africa and Arabia as representing the true A. marina (Forsk.) Vierh. He regards those to the east [tropical Asia, Indonesia, and Melanesia] as var. intermedia (W. Griff.) Bakh. This may prove to be a desirable segregation, but at present I see no good way of distinguishing these presumed taxa morphologically. Some very small roundish-leaved specimens from the Malayan area certainly seem fairly distinct, but may actually represent A. sphaerocarpa Stapf. They hardly fit into Bakhuizen's characterization of var. intermedia although they have been so regarded by some workers.

Backer & Bakhuizen (1961) use the name, A. marina var. intermedia, for A. marina as it occurs in Java, describing it as having "Flowers in 2—12-flowered heads; lowermost flower-pair sometimes distant from the other ones, but nevertheless the inflorescence not spiciform; adult heads 1/2 — 1 1/5 cm long; style robust, c. 1 1/2 mm long; stigmas recurved. Leaves elliptic-oblong or oblong-obovate, from an acute base, with an obtuse or rounded top, greenish white beneath, 3—9 cm by 1 1/4 — 4 1/2 cm....... mangrove (also in the more saline parts), banks of tidal streams".

Griffith (1846) has stated that his A. intermedia — the basis for Bakhuizen's A. marina var. intermedia — is "altogether intermediate between what appears to be A. tomentosa and A. resinifera". To exactly which "A. tomentosa" he is here referring is not clear. The A. tomentosa of Blanco is now known as A. marina var. rumphiana (H. Hallier) Bakh., that of Blume is A. alba Blume, that of Robert Brown and of Sieber (in part) as A. marina var. resinifera (Forst. f.) Bakh., that of Jack, Jacquin, Linnaeus & Jacquin, G. F. W. Meyer, Nuttall, Nuttall & Brown, Sieber (in part), Swartz, and Weigelt is A. germinans (L.) L., that credited to Linnaeus, to Vahl, and to Wallich is true A. marina, and that of Roxburgh and of Willdenow is A. officinalis L., while that accredited to Schauer, to "sensu Marc.", and to "sensu Mayc." is A. schaueriana Stapf & Leechman. I assume that Griffith is referring to the A. tomentosa of Roxburgh and therefore to A. officinalis L. It is true that typical A. marina does appear more or less intermediate between A. officinalis and A. marina var. resinifera, but this does not indicate or even imply that it is a hybrid between them.

Greenway (1973) asserts that A. marina is the "common dominant on the landward sides of the [saline water] swamp forest" in East

Africa. Alston (1931) distinguishes the two Sri Lankan species as follows:

1\. Leaves obtuse, obovate; anthers exserted; style elongate, villous; corolla over 1/4 inch across; capsules 1—1 1/2 inches across; ovary hairy [throughout]............*A. officinalis*.

1a. Leaves acute, elliptic; anthers included; style very short, glabrous; corolla under 1/4 inch across; capsule 1/4 — 1 inch across; ovary hairy at apex only............*A. marina*.

He assert that *A. marina* is "common on the seacoasts of Ceylon, also on all tropical Asian shores".

It should be noted here that the *A. officinalis* Auct. ex Jafri, referred to in the synonymy on page 76, is a synonym of *A. marina* var. *acutissima* Stapf & Moldenke, while the homonym referred to as *A. officinalis* Auct. ex Allan is *A. marina* var. *resinifera* (Forst. f.) Bakh., that credited to Blume is the true and valid *A. officinalis* L., that credited to Kurz, to H. J. Lam, to "(L.) Kurz", and to Watt is *A. alba* Blume, that accredited to Millspaugh is *A. germinans* (L.) L., that credited to Schauer is *A. marina* var. *rumphiana* (H. Hallier) Bakh., and that of Miquel is *A. eucalyptifolia* Zipp. The *A. nitida* Blanco, referred to on the same page, belongs in the synonymy of *A. marina* var. *rumphiana*, while the homonym credited to "(Alter.) Sessé & Moç", to Jacquin, to Linnaeus, to Linnaeus & Jacquin, to Rodschuh, and to Sessé & Moçino are *A. germinans* (L.) L.

Altman & Dittmer (1966) refer to *A. marina* as the "black mangrove", but they, as well as Biebl (1964), erroneously list *A. nitida* Jacq. as a synonym — Jacquin's binomial is a synonym of *A. germinans*. The "*A. marina*" of Jafri (1973) is plainly var. *acutissima* Stapf & Moldenke. Uphof (1968) reduces *A. alba* Blume to the synonymy of *A. marina*, but this disposition is entirely untenable to me because *A. alba* has plainly spicate inflorescences and very much differently shaped leaves and fruits. The "*A. tomentosa* L." of Wallich (1831), of Decaisne (1834), of Harvey (1838), and of Drury (1858) actually is *A. marina*. Harvey (1838) asserts that "It is found pretty generally through the tropics, and in countries bordering on them, in similar situations" — a statement which is far too broad, applicable, really, only to the genus as a whole, rather than to any one species like this one. No form of *A. marina* occurs in the New World.

The "*A. officinalis* L." of Harvey (1868), of Matsumura (1899), of Baker (1900), of Almagia (1903), of Dunn & Tutcher (1912), of Sakaguchi (1924), of Parthasarathy (1927), of Sasaki (1928), of Makino & Nemoto (1931), of Nemoto (1936), of Sonohara, Tawada, & Amano (1952), of Naito (1953), of Montasir & Hassib (1956), of Verguin (1956), of Khattab & El-Hadidi (1971), and of Weiss (1972) is actually *A. marina*.

Melchior (1964), DeWit (1967), and Amico & Bavazzano (1968)

list "A. officinalis L." as a synonym of A. marina, while Corner & Watanabe (1969) reduce A. marina to the synonymy of A. officinalis, but these are absolutely untenable dispositions — the A. officinalis of Linnaeus is a separate, very distinct, and valid species [see Alston's distinguishing characters as quoted on page 85].

Masamune (1955), misidentified as A. officinalis, records A. marina from Fukien, Taiwan, Iriomoto, Ishigaki, Komi, Miyako, and Obama. Rageau (1957), also misidentifying the plant as A. officinalis, quotes Verguin (1956) to the effect that "à Madagascar, l'infusion de feuilles est préconisées contre la fièvre jaune". As yet I have been unable to check the illustrations of "A. officinalis said to be in Annal. Mus. Colon. Marseille, ser. 4, 4: 2, pl. 64 (1926) and in Mém. Acad. Malgache 5: pl. 20, fig. 56 (1927), but if these apply to Madagascar plants too, then probably they also depict A. marina rather than the true A. officinalis.

Kohlmeter (1971) reports a fungus on what he identifies as "A. germinans" from South Africa, but the only species of Avicennia in South Africa is A. marina. Steinke (1972) found the species more widely distributed in Cape Province [Cape of Good Hope] than Bruguiera gymnorrhiza. Bavazzano (1972) reports it from Afars & Issis Territory. Täckholm (1956) tells us that A. marina is found on the Red Sea coasts and on adjacent islands of Egypt, where it is known locally as "shoara". Montasir & Hassib (1956) also assert that it is frequent along the Red Sea coasts. Foreman (1972) records it from Bougainville island and Williams (1949) from Pemba and Zanzibar, where, he says, it is usually found "at higher levels in [the] mangrove association". Gaussen and his associates describe it as "serving as coloniser on mangrove deltas" and of "intertidal zones and estuaries".

Speck (1968) states that A. marina grows with Rhizophora stylosa, Aegiceras corniculatum, and Osbornia octodonta, forming a dense single-layered forest 20—40 feet tall, access to which is difficult because of the density of the forest and the deep tidal mud in which it grows. Beard (1967) report that "A colony of Avicennia marina was found along a salt creek [in Western Australia] leading from an inland source through a series of small salt lakes and salt flats to an estuary-like area along the '80-mile Beach'". This, he says, "gives us an example of an inland locality for this species." He discusses habitat factors and the accompanying vegetation, emphasizing the factors which could have led to such an establishment of an inland mangrove colony. The species is also known to me from several inland salt lakes in northeastern Africa.

Chapman (1970) proposes the ecologic associations, Avicennietum marinae and Avicennieto albae-A. marinae.

The Gillis 8388 collection, cited below, cultivated in Florida, was grown there from seeds gathered on Formosa and planted at the edge of a tidal swamp in marl. Kassas, Mobarak, & Omar 636 and

Täckholm, Kassas, Faway, Shalaby, Samy, & Zahran 1150 consist of seedling specimens.

Additional vernacular names to those previously reported by me for this species are "black mangrove", "grey mangrove", "hái-ka-tang", "hái-ka-tîn", "hirugidamasi", "hirugi-damashi" [=hirugi, mangrove, damashi, to be deceived, implying that one is deceived into thinking that this is the true mangrove plant, the true mangrove being Rhizophora], "hirugi-damasi", "hirugi-modoki", "isi kungathi", "isí-kungati", "kanamaram", "kanna", "mcandella", "mchmu wood", "mtswi", "mtu", "mutu", "salgheiro", "shoara", "shora", "takhai", "takhaye", "takhei", "tobase", "tokhai", and "venkandan".

Arulchelvam (1968) describes A. marina as it grows in Sri Lanka: "A bush or small tree, much branched, white bark; young twigs quadrangular. Leaves 2 to 3 inches long and 1 to 1 1/2 inches broad, 6 to 8 opposite veins, Petioles 1/4 to 1/2 inch. Dark green above and silvery white below with densefine pubescence. Oblanceolate, acute at base. Flowers. — In terminal or axillary panicles, yellow, corolla 1/2 inch diameter. Fruit. — Capsule about 1 inch, obliquely ovoid, compressed, glabrous, pale greenish yellow. Wood. — Has included phloem does not burn well.... Distributed in all the mangrove swamps in Ceylon. Produces a large number of pneumatophores of 6 to 18 inches height and 1/4 to 1/2 inch thick." As usual, this is a hodgepodge of A. marina and A. officinalis characters!

Palmer & Pitman (1972) refer to A. marina as "the southernmost mangrove in Africa". They assert that from the Kabonqaba River in Cape Province "it extends northwards along the coasts of Natal, Zululand, and Portuguese East Africa to tropical Africa and the Red Sea, and eastwards to the tropical shores of both hemispheres [actually, it does not occur naturally in the Western Hemisphere at all!].....This is the boldest of the mangroves, the pioneer and first colonizer, starting life on the fringes of the lagoon and inlet shores, sending up from its wide-spreading horizontal roots its numerous pencil-like 'breathing-roots' which father silt, in time making around them a muddy and waterlogged world in which other mangrove species of the genera Rhizophora and Brugiera take over. Unlike the trees of these species, it is a sun-lover, tending to disappear at length under the new conditions it creates. In a mangrove swamp it usually constitutes the outer fringe. Its roots are often covered at high tide and it can stand a considerable degree of salinity.

"It is a shrub or small, slender, willow-like tree up to about 6 m high — its height, it is suggested, depending largely on the type of soil, for it flourishes best where drainage is good. Unlike the other mangroves, the foliage appears light and airy, the leaves often growing upwards. The trunk, which usually grows at an angle, is most often slender and light-coloured, covered with small raised dots and occasionally flaking to show green below."

They describe the "thousands" of pneumatophores as 15—38 cm. long and state that "among them scuttle hundreds of tiny dark

crabs feeding on the fallen fruit......They [the trees] bloom from August to October.....The seedlings.....are not long and cigar-shaped as in Bruguiera and Rhizophora, but small -- about 2.5 cm. long -- cone-shaped, well-formed for mobility, and easily borne and scattered by the tidal waters. After they have fallen the cotyledons unfold and develop. Birds of various species nest in the tree", including cattle egret, little egret, gray heron, black-headed herons, and golden weavers; "Bronze Mannikins roost in it. The Wattle-eyed Flycatcher is sometimes to be seen feeding in avicennia groves, flitting about and catching insects with a loud snap of its bill. The Mangrove Kingfisher is associated with it as far south as the last dense avicennia grove on the Kobonqaba River.

"Sim called this the least useful and most persistent of the three hardy mangroves [in South Africa]. He described the wood as grey or yellowish, prettily dotted and fairly dense and even, the older timber with a darker centre and often damaged. It is said to be durable and is used for poles, and in parts of Africa in ship-building -- the ribs of dhows are sometimes fashioned from it. In Tongaland the framework of the local fish traps, which are large and conical, is made from it. The bark and roots contain tannin and a brown dye is obtained from the bark."

Chai (1972) describes A. marina in Sarawak as a "Shrublet (2 ft. tall) to medium-sized tree -- 60 ft. tall. No buttresses but slender, soft stilt roots may develop. Bark reddish-brown, flaking off in irregular, thin papery flakes revealing green new bark surface.....A pioneer species on new mud with a high proportion of sand but does not seem to colonise pure mud. At the mouth of the Bako river, it is slowly been replaced by A. alba. Found also along sandy shores where it is seen to be in poor form and never gregarious. Absent inland."

Dale & Greenway (1961) assert that in Kenya A. marina "is a first coloniser of poor swamp land. Once established mud usually accumulates amongst its pneumatophores producing conditions favourable for Ceriops and occasionally Rhizophora. In established swamps the tree occupies the zone on the landward side."

Amico & Bavazzano (1968) say of its uses: "Radici: afrodisiaco. Frutto: il frutto immaturo è usato per curare piaghe e lesioni cutanee da vaiolo. Semi: cotti in acqua sono adoperati coma cicatrizzanti di ferite. Pianta intera: contienne tannino."

Burkill (1966) says: "A tree usually not more than 40 feet high, though sometimes up to 70 feet, found gregariously on the sea-face of the mangrove belt....It is a very valuable tree from the point of view of anchoring mud, and after a time it gives place to the more valuable Bruguiera caryophylloides.....as this happens, it becomes a scant value."

Moll and his associates (1972) note that the mangrove association in South Africa is "important for the conservation of the estuaries which are needed during the life cycles of many marine organisms" and "in some areas around the larger cities it has been almost completely destroyed".

Uphof (1968) asserts that the hard wood is used to make pillars of houses and also as fuel, the aromatic bitter juice is used as an abortive, and the bark is employed in tanning. Williams (1949), on the other hand, says that in Pemba and Zanzibar it is "useless for tanning". Yet Dale & Greenway (1961) report that in Kenya "A brown dye is obtained from the bark. The bark and leaves have up to 6 per cent tannin. The timber is used for dhow ribs and is liked as fuel for lime burning." Harvey (1838) asserts that in South Africa the bark is used for tanning. Williams (1949) claims that in Zanzibar the trunks are used to make canoes, in cart building, as fittings for dhows, as masts, bedstools, drums, chairs, and handles, and "Used as fuel in lime burning". Tanner avers that in Tanzania the leaves are boiled and the resulting liquid is then drunk in treating fevers.

Parsa (1947) states that small relict communities of this plant (which he misidentifies as A. officinalis) are found on tidal estuaries at intervals along the Gulf of Aden coast from beyond Jibuti to Karin and probably to Cape Gardafui. Chiovenda reports them from along the eastern Somali coast. Parsa avers that it does not seem able to adapt itself there to deeper water and so grows nearer to the edges, sometimes even on "dry" ground where it can attain a height of 20 feet. It supplies building timber for gurghis, the bark is "rich in tannin", and it provides good stock feed especially for camels and because of this it is being depleted very rapidly.

Watt & Breyer-Brandwijk (1962), erroneously identifying the plant as A. officinalis, list its uses in southern and eastern Africa as follows: the bark and roots are used for tanning "and the wood has been explored as a possible source of paper pulp. The root has been used as an aphrodisiac and a cataplasm of the unripe fruit for sores and for healing the skin lesions of small-pox."

Burkill (1966) informs us that "About the Red Sea and the Persian Gulf, where fodder is a thing of much value, the leaves of A. marina are eaten by camels......Cattle eat the leaves of the Australian Avicennia, or Grey Mangrove, with great relish. A green, bitter and somewhat aromatic resin oozes from the bark. This resin is medicinal round about the Indian Ocean. An Arab writer calls it an aphrodisiac, and adds that it may also be applied for toothache. In western Java it is considered a contraceptive, and is taken over indefinitely long periods....This use is given, also, by Ridley as known among the Malays....but in his prescription the abortient juice of a young pine-apple is associated. Watt.....says that the roots possess aphrodisiac properties. He says that unripe seeds are used as a poultice to hasten boils and abscesses to maturity. The ash, after burning the wood, is used as soap in India......and Baker tells us that early settlers used it similarly in Australia. There is a large amount of alkali in it.....Wood-tar was made from it experimentally by Wells"

Leshem & Levison (1972) report that A. marina "manifests several regulation mechanisms enabling survival in extreme saline

and anaerobic conditions. Anatomical adaptations include vertically growing aerial roots — pneumatophores, extending above sea level at high tide and which are equipped with aerenchyma and profuse lenticels thus enabling 'tidal breathing'. Physiological adaptations include high osmotic potentials — 69 atmospheres — as measured by Vapour Pressure Equilibrium method, and active ion excretion from lower epidermis of foliage. Ultra-filtration seems the case only for the CO_3^{--}, SO_4^{--} and Mg^{++} ions. The transpirational system apparently is affected by salt encrustations on the leaves only to a minor degree."

Shimony, Fahn, & Reinhold (1973) have found the salt glands of A. marina to consist of "2—4 collecting cells, 1 stalk cell and usually 8 secretory cells. The side wall of the stalk cell is completely impregnated with electron-dense material. An amorphous substance appears between the upper walls of the secretory cells and the cuticle above them. The latter possesses many narrow channels. The ultrastructure of the secretory cells was studied under various conditions. The protoplast is usually dense and poorly vacuolated. The nucleus is relatively large and the cytoplasm rich in organelles, especially endoplasmic reticulum (E.R.) elements, Golgi bodies and mitochondria. There are many vesicles which appear to be derived from the Golgi bodies and from E.R. cisterns. Elongated vacuole-like structures, apparently derived from Golgi cisterns, and membranous bands were also observed: it is suggested that both represent different stages of the same structure. In many glands the protoplast appeared to be contracted in one of the secretory cells and the space between it and the cell wall was filled with an amorphous electron-dense substance. Antimonate precipitation and electron probe analysis were employed to locate ions in the tissues. Both techniques indicated that the salt content of the gland cells was lower than that of the mesophyll. A downhill gradient appeared to exist from cells near the xylem, through the mesophyll to the gland, and was continued through the gland itself." Rains & Epstein (1967) have investigated the preferential absorption of potassium by the leaf-tissue in the presence of high concentrations of sodium chloride.

Connor (1969) reports that when A. marina was grown in nutrient cultures to which a range of concentrations of NaCl, KCl, and CaCl were added, all levels of KCl and CaCl suppressed growth, but there was a positive growth response to NaCl, the optimum level being about 1.5 percent, which is half the concentration of sea water.

Puri (1960) reports an osmotic pressure of 48.5 atmospheres in A. marina, as compared to 38.6—41.29 in A. alba and 41.93 in A. officinalis. Other mangroves had the following pressures: 31.45 in Sonneratia alba, 14.99—45.46 in S. apetala, 31.6—33.7 in Rhizophora mucronata, 26.65—32.45 in Ceriops candolleana, 24.92—33.25 in Acanthus ilicifolius, and 27.9—32.23 in Bruguiera gymnorrhiza.

Lewis & Naidoo (1970) have investigated the effect of tidal inundation on the apparent transpirational rhythm of A. marina by use of a Ganong potometer. "The apparent transpiration rate of this plant rises in the morning with increasing light intensity and decreasing relative humidity until a mid-morning maximum is attained. Thereafter a progressive decrease in rate takes place during the rest of the day, regardless of atmospheric conditions. Tidal inundation of the swamp after the mid-morning maximum results in an increase in apparent transpirational rate and the attainment of a 2nd maximum, indicating that the initial decrease in rate was probably caused by incipient wilting following excessive transpiration and consequent increased soil water tension."

Bell & Duewell (1961) have isolated betulic acid, taraxerol, taraxerone, and traces of a hydrocarbon (probably triacontane) from the bark.

It is perhaps also worth noting here that the Blume (1826) reference in the bibliography of A. marina is often cited as "1825". Burkill cites the Baker (1915) reference as "1916". The Foreman (1972) work is sometimes cited as "1971", the title-page date. Similarly, the Täckholm & Boulos (1974) work is cited as "1972", the title-page date, but the work was not actually published until November 20, 1974. The Griffith (1846) reference is sometimes given as "1851" and the Chapman (1960) work as "1954".

Dale & Greenway (1961) cite Graham 231, Greenway 8933, Jeffery 125, Swynnerton 196, and Webber 617 from Kenya. Amico & Bavazzano (1968) cite their no. 448 from "Inhassunge: lungo le sponde del fiume Bons Sinais e suoi affluenti nella mangrovia". Iyengar (1927) lists an "A. officinalis", which is probably A. marina, from Krusada in the South Indian Sand Cays, where Stoddart & Fosberg (1972) cite Stoddart 1515 from West Cay, Stoddart 1614 fron New Cay, and Fosberg 51242 from Manauli Cay. Khattab & El-Hadidi (1971) cite their no. 210 from Hejaz. Fosberg & Renvoize (1970) cite Fosberg & Grubb 49825 and Fryer 22 from Wizard Island and Gwynne & Wood 1260 and Stoddart & Poore 1225 & 1259 from Menai Island.

Fosberg (1970) cites Fosberg & Frazier 49758, Hemsley s.n., Ridgeway 67, Veevers-Carter 67, and Vesey-Fitzgerald 5960 from Astove Island. Bayne and his associates (1970) record the species from Cosmoledo Atoll, Menai Island. Täckholm (1969) cites Kaiser 79, 909, 948, 980, and a photograph. Voigt (1845) records it as cultivated in the Calcutta suburbs in India. Huang (1972) cites Chang 2229 from Formosa (Taiwan).

The R. M. King 5588 & 5601 and Orolfo 690, distributed as A. marina, are actually A. alba Blume, while Havel NGF.17393 and Soepadmo KLU.9162 are A. alba var. latifolia Moldenke, Latz 3391 [Herb. North. Terr. 36913] and Neth. Ind. For. Serv. bb.24334 are A. eucalyptifolia Zipp., Budowski 96-288 & 118-18 are A. germinans (L.) L., Lohen 14879, Medway s.n., and Turnau 745 are A. marina var. rumphiana (H. Hallier) Bakh., Sterimann & Lelean

NGF.18468 is A. officinalis L., and Schlieben 11753 is not avicenniaceous. Gardner s.n. [Thwaites C.P.1961] is a mixture of A. marina and A. officinalis.

Additional citations: EGYPT: Boulos 445 (Gz); Collector undetermined s.n. (Gz 4 sheets); Hassib s.n. [Jan. 18—25, 1930] (Gz 3 sheets), s.n. [30/1/1930] (Gz 5 sheets); Hassib & Fahmy s.n. [11/1/33] (Gz 7 sheets); Nayal s.n. [23/1/1929] (Gz 4 sheets); Osborn & Helmy s.n. [9/3/1967] (Gz); Sabat & Nayal s.n. [Ghargada, July 1933] (Gz 5 sheets); G. Schweinfurth 966 (W—2497120); G. Täckholm s.n. [21/1/1929] (Gz 34 sheets); Täckholm, Kassas, Faway, Shalaby, Samy, & Zahran 1150 (Gz 10 sheets), 1151 (Gz 7 sheets), 1428 (Gz, Gz), 1593 (Gz 3 sheets); Täckholm, Kassas, Samy, Girgis, & Zahran 7 (Gz, Gz), 24 (Gz 3 sheets), 450 (Gz, Gz); Zahran & Girgis 43 (Gz 3 sheets), 71 (Gz 3 sheets), 86 (Gz). SUDAN: Red Sea: Kassas 829 (Gz), 865 (Gz 6 sheets), s.n. [5.1.1956] (Gz 4 sheets); Kassas, Mobarak, & Omar 636 (Gz, Gz), 931 (Gz), 1170 (Gz 3 sheets). BAKIYAI ISLANDS: Aqiq: Kassas, Mobarak, & Omar 920 (Gz 3 sheets). ERITREA: Pappi 3168 (W—1969130). ABU MENQAR ISLAND: Sabat & Nayal s.n. [6 July 1933] (Gz 5 sheets); Täckholm, Kassas, Samy, Girgis, & Zahran 47 (Gz 3 sheets). REPUBLIC OF SOMALI: Renner s.n. [Oktober 1930] (Mu). TANZANIA: Tanganyika: Perdue & Kibuwa 8475 (Mu); Schlieben 5787 (Mu); Tanner 2464 (Ba, N), 3414 (Ba, N); Verdoorst 132 (Mu). KENYA: Greenway 8933 (N), 8935 (N); Greenway & Rawlins 8875 (N). MOZAMBIQUE: Manica e Sofala: Shantz 365 (W—1657224). SOUTH AFRICA: Natal: Strey 6727 (Mu); Wirter 7713 (Mu). COMORO ISLANDS: Aldabra: F. R. Fosberg 48674 (N), 48675 (N). Euphrates: F. R. Fosberg 48779 (N). SEYCHELLES ISLANDS: Cousin: F. R. Fosberg 52048 (W—2680166). Mahé: Jeffrey & Zelia 494 (N). NOSY-BÉ: L. Bernardi 11814 (W—2749344). ARABIA: Hedjaz: Khattab 210 (Gz); Migahid 14 (Gz), 515 (Gz); Schimper 736 (Mu). Yemen: Ibrahim K.2328 (Gz). Province undetermined: Schimper s.n. [Ad mare rubrum] (Mu). PERSIAN GULF ISLANDS: Tarut: Khodair 36 (Gz); Migahid & Hammouda 104 (Gz). INDIA: Gujarat: Jain s.n. [Bhaunagar, Gogha, 13.5.1957] (Gz). Karnataka: Thanikaimoni s.n. [Karwar, 6.4.75] (Ld). Kerala: Manilal 10 (Ac). Tamil Nadu: Thanikaimoni s.n. [Pichavaram, 17.7.1973] (Ld). SOUTH INDIAN SAND CAYS: Manauli: F. R. Fosberg 51242 (W—2669635). New: Stoddart 1614 (W—2625112, W—2625113). West: Stoddart 15151 (W-2625018). SRI LANKA: Amaratunga 110 (Pd), 1830 (Pd), 2073 (Pd); Balakrishnan NBK.362 (Pd, W—2720383); Collector undetermined s.n. [Jaffna, Feb. 1870] (Pd), s.n. [Panadura] (Pd), s.n. [Puttalam lagoon] (Pd, Pd); Cooray 69073011R (N, W—2657004), 69092801R (W—2657006), 69100505R (W—2657005); Fosberg, Mueller-Dombois, Wirawan, Cooray, & Balakrishnan 50914 (Ld); G. Gardner s.n. [Thwaites C.P.1961, in part] (Pd); Gould & Cooray 13670 (Pd, W—

2574884a); Grupe 106 (Pd, W—2611411), 110 (Pd, W—2611412); Macrae s.n. [Kalpitiya, Oct. 21, 1968] (N, W—2680246), s.n. [November 10, 1968] (W—2679407, W—2680249); Meijer 752 (Pd, W—2760727); Meijer & Balakrishnan 131 (Pd, W—2716022); Moldenke, Moldenke, & Jayasuriya 28246 (Ac, E, Gz, Kh, Ld, Pd, Tu, W—2765420); R. W. Read 2172 (W—2691085); J. M. de Silva s.n. [Puttalam] (Pd); Y. W. de Silva s.n. [Negombo] (Pd); N. D. Simpson 9856 (Pd); Thwaites C.P.1961, in part (Pd); Tirvengadum, Cramer, & Balasubramium 244 (W—2764110); Tirvengadum & Waas 465 (N); Worthington 478 (Pd), 4386 (Pd), 4891 (Pd). SRILANKAN ISLANDS: Erumativu: Macrae s.n. [October 22, 1968] (W—2679408). THAILAND: Geesink & Santisuk 5240 (Ac); Larsen & Larsen 33784 (Ac); J. F. Maxwell 71-349 (Ac), 72-335 (Ac); Surapat 358 (W—2450897); Van der Kevie 2 (N). MALAYA: Singapore: Chai PC.2 (Kl—14975); Gill 24 (Ba, Ft—9689, Ld); Mahmud s.n. [May 1970] (Kl—13370). RYUKYU ISLANDS ARCHIPELAGO: Ishigaki: F. R. Fosberg 37425 (Ld, W—2628908). PHILIPPINE ISLANDS: Bosan: J. V. Santos 4748 (W—2246293). Luzon: Gill 1 (Ac, Ft—9730, Ld), 2 (Ft—9731); Mabanag s.n. [Philip. Nat. Herb. 9599] (W—2125857, W—2376130, W—2376131); Pancho 2085 (Ba). Mindanao: H. H. Bartlett 13706 (Mi). Mindoro: Conklin s.n. [Philip. Nat. Herb. 18725] (W—2214844); J. V. Santos 5148 (W—2246563). GREATER SUNDA ISLANDS: Java: Backer 15324 (Mu, Mu), s.n. [Batavia] (Mu, Mu); Renner s.n. [26. 11.1930] (Mu). Sarawak: Carrick & Enoch JC.265 (Kl—3250); Chai S.26762 (Ac, Ft, Ld), S.26763 (Ld), S.26765 (Ac), S.27541 (Ld), S.29948 (Ld), S.29950 (Ac), S.30627 (Ac), S.30660 (Ld). LESSER SUNDA ISLANDS: Wetar: Neth. Ind. For. Serv. bb.27297 (N). NEW CALEDONIAN ISLANDS: New Caledonia: L. H. MacDaniels 2010 (Ft—3852). CULTIVATED: Florida: Gillis 8388 (Ac, Ft—4717). LOCALITY OF COLLECTION UNDETERMINED: Collector undetermined 59 (Pd).

AVICENNIA MARINA var. ACUTISSIMA Stapf & Moldenke

Additional synonymy: Avicennia marina var. acutissima Stapf & Moq. ex Rao, Aggarwal, & Mukherjee, Bull. Bot. Surv. India 8: 65, sphalm. 1966. Avicennia alba Auct. ex Raizada, Indian Forester 92: 306, in syn. 1966 [not A. alba Blume, 1826, nor Karst., 1907, nor Miq., 1891, nor Wight, 1921]. Avicennia officinalis Auct. ex Jafri in Nasir & Ali, Fl. West Pakist. 49: 2, in syn. 1973 [not A. officinalis Auct. ex Allan, 1961, nor Auct. ex Cuf., 1962, nor Blume, 1960, nor Kurz, 1885, nor L., 1753, nor "L. sens. lat.", 1965, nor (L.) Kurz, 1938, nor H. J. Lam, 1940, nor Maxim., 1932, nor Millsp., 1930, nor Miq., 1918, nor Schau., 1856, nor "sec. auct. afr.", 1961].

Additional bibliography: C. B. Clarke in Hook. f., Fl. Brit. Ind. 4: 604. 1885; T. Cooke, Fl. Bomb. Presid. 2: 436. 1906; Parsa, Fl. Iran 4 (1): 536—537. 1949; Raizada, Indian Forester 92: 302. 1960; S. A. Khan, Pakist. Journ. Forest. 11: 43—45.

1961; Jafri, Fl. Karachi 290, 339, & 351, fig. 285. 1966; Raizada, Indian Forester 92: 306. 1966; Rao, Aggarwal, & Mukherjee, Bull. Bot. Surv. India 8: 65. 1966; Santapau, Bull. Bot. Surv. India 8: 37, 40, & 291. 1966; Esfandiari, Prem. Liste Pl. Herb. Minist. Agr. Iran 252. 1967; Rao & Mukherjee, Bull. Bot. Surv. India 9: 81, 83, 84, & 86, fig. 1. 1967; Rao & Shanware, Bull. Bot. Surv. India 9: 244 & 247. 1967; Santapau, Bull. Bot. Surv. India 8, Suppl. 1: [Fl. Saurashtra] 38. 1967; Moldenke, Phytologia 15: 476. 1968; Moldenke, Résumé Suppl. 16: 9. 1968; Shah & Patel, Bull. Bot. Surv. India 12: 20 & 25. 1970; Moldenke, Fifth Summ. 1: 267, 271, 279, & 392 (1971) and 2: 839. 1971; Patel, Forest Fl. Gujarat 35 & 227. 1971; Moldenke, Phytologia 23: 422. 1972; R. R. Stewart, Annot. Cat. in Nasir & Ali, Fl. West Pakist. 605. 1972; Jafri in Nasir & Ali, Fl. West Pakist. 49: 2—4, fig. 1. 1973; Simon, Dormer, & Hartshorn in Lowson, Textb. Bot., ed. 15, [64], pl. 3. 1973; Moldenke, Phytologia 28: 453 (1974), 29: 173 (1974), 31: 389 (1975), and 32: 442, 443, & 452. 1975.

Illustrations: S. A. Khan, Pakist. Journ. Forest. 11: 45 (in color) [as "A. officinalis"]. 1961; Jafri, Fl. Karachi fig. 285 [as "A. alba"]. 1966; Jafri in Nasir & Ali, Fl. West Pakist. 49: 3, fig. 1 [as "A. marina"]. 1973; Simon, Dormer, & Hartshorn in Lowson, Textb. Bot., ed. 15, pl. 3. 1973.

This taxon has been confused widely with A. alba Blume by practically all authors up to 1938 and even since then by Jafri (1966) and by Stewart (1972), as A. officinalis L. by Khan (1961), and as typical A. marina (Forsk.) Vierh. by Jafri (1973). Raizada (1966) comments that "Apparently two different plants, one from the east coast and one from the west coast of India have been going under the name A. alba Bl. The east coast specimens [the true A. alba] are trees with lax inflorescence and cylindrical fruits. The west coast specimens are shrubs with compact inflorescence and laterally compressed fruits. From Blume's description it is difficult to determine as to which of these two is the real A. alba Blume. I have followed Moldenke here who identifies the west coast specimens as A. marina var. acutissima Stapf & Moldenke."

It should also be pointed out here, for the record, that the A. alba of Miquel, referred to in the synonymy above, is a synonym of A. alba Blume, while the homonym credited to Karsten is really A. eucalyptifolia Zipp. and that credited to Wight is the typical A. marina (Forsk.) Vierh. The A. officinalis credited to Kurz, to H. J. Lam, and to "(L.) Kurz" is a synonym of A. alba Blume, while that credited to Miquel is A. eucalyptifolia Zipp., that credited to "Auct. ex Cuf.", to "L. sens. lat.", to Maximowicz, and to "sec. auct. afr." is typical A. marina (Forsk.) Vierh., and that credited to Millspaugh is A. germinans (L.) L. The so-called A. officinalis Auct. ex Allan is really A. marina var. resinifera (Forst. f.) Bakh., A. officinalis Schau. is A. marina var. rumphiana (H. Hallier) Bakh., while that credited to Blume is the true A. officinalis L. [to be continued]

BOOK REVIEWS

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"A DICTIONARY OF BIOLOGY" by M. Abercrombie, C. J. Hickman, and M. L. Johnson, Ed. 6, 311 pp., 10 figs., Penguin Books, Baltimore, MD. 1973. $1.95.

This small paper-back may be said to have a high density--much information condensed into a small space. A calculated effort has been made to not define any single plant or animal organism, although a few groups are now and then defined (e.g., Pinnipedia, Gnetales). The emphasis is on general terms of biology, words like enamel, enation, glycosides, implant, and so on. A strong weeding of biological terms of lesser importance is in evidence. Thus, there would be no point in presenting a list of terms which were not covered, because this is not an exhaustive or unabridged listing. It is intended for three groups: laymen, beginning biology students, and biologists who are not fully competent in fields outside of their own. The publishers have not put this book into a hard-back obviously because they feel there are too many and too rapid changes in biological vocabulary so that a user would rather spend less and buy more often; hence the frequent revisions.

GMH

"DICCIONARIO DE BOTANICA" (DICTIONARY OF BOTANY), João Angely, (Director, Instituto Paranaense de Botanica, Curitiba, Parana, Brazil), Ed. 2, 403 pp. Edições Phyton, Caixa Postal 1,362, Curitiba, Brazil. 1959.

This most comprehensive dictionary of botanical terms in Brazilian Portuguese is composed of two alphabetical sequences, the first extending over pp. 19-371, the second ("Addenda") over pp. 371-403, and representing additions presumably made since edition 1 (1947). Included are 17,000 words, 28,000 definitions, and 3,500 synonyms, all relating to botany and agronomy and the subdivisions of these fields. It represents 17 years of labor, with the consultation of 1700 technical works in the field. In binding this paper-covered book, the covers should be retained and bound in, since they bear biographical data on the author, with a list of his publications. One difficulty in using this book is the lack of running content titles on each page. It would have been very useful to

have had placed on each page the first entry on the left page, the last entry on the right page of a double spread: thus, on page 92, "C" or "Con(i)" or "Conifero" on the upper left, and "C" or "Cor(o)" or "Coroa" on the upper right page (p. 93). This would have facilitated the use of the dictionary. It is difficult to understand why this was not done since this device is so very commonly used by dictionaries the world around.

GMH

"PLANTES MEDICINALES DU CONGO-BRAZZAVILLE: UVARIOPIS, PAURIDIANTHA, DIOSPYROS" by Armand Bouquet, Travaux et Documents de l'O.R.S.T.O.M. No. 13: 113 pp., 28 figs., tabs. (s.n.). ORSTOM. - 24, rue Bayard, Paris 8^{e}. Prix de vente: 32 Francs.

In the present publication of L'Office de la Recherche Scientifique et Technique d'Outre-Mer (ORSTOM), species of three genera are considered in considerable detail. In addition, Part I releases data from a chemical screening survey covering 350 plant species. In the course of this study of plants, mostly those considered medicinal by the Congolese peoples, alkaloids were discovered in 82 plants (28 families), quinones in 13 species, cyanophoric glycosides in 16 plant entities, and flavonoids in 41 different species. In addition, saponosides, terpenes, and tannins have been reported in many other plants. Many of these plants are little if at all known from a chemical standpoint. In the concentrated study of a few drug plants, the stem and root bark of Uvariopis solheidii revealed the presence of the alkaloid, diethylamino ethyl-1-methylenedioxy-3, 4-methoxy-7-phenanthrene, called uvariopsine, a member of the aporphines. The three Pauridiantha species showed closely similar chemical properties, with an anthraquinone in the bark. In P. callicarpoides and P. viridiflora, harmane and other alkaloids were found, one denominated pauridianthine, a member of the indole group of alkaloids. Barks of P. callicarpoides contained scopoletol. Root barks of three Diospyros species showed a triterpene acid, betulinic acid, and various naphthoquinones.

GMH

"THE WORLD OF THE VIRUSES" by Stewart M. Brooks, 162 pp., 28 figs., 1 portr. A. S. Barnes and Co., Inc., Cranbury, N.J. 1970(1971). £ 2.25(45 s) = ca $3.30

In this slender volume, there is presented most interestingly the story of those very important substances which cause so much and such very severe, often deadly, diseases. There are separate chapters on mumps, influenza, measles, rabies, polio, the common cold, serum and infectious jaundice, smallpox,

and others. The headings of the chapters often give no clue to the contents; thus, "Lady Montagu" is the title of a chapter dealing with smallpox, "Blood and oysters" deals with the jaundices, "Two for one" is a chapter on chickenpox, and so on. Enough personal biographic information is incorporated to give a good deal of human interest in the account, with sufficient scientific information to make it an excellent learning experience. The book is lacking in difficult technical jargon and should be readily understandable to the layman. Many references, both technical and non-technical, are given.

GMH

"TEXTBOOK OF MICROBIOLOGY" by William Burrows, Ed. 20, xix + 1035 pp., 294 figs. W. B. Saunders Co., W. Washington Sq., Philadelphia, PA 19105. 1973. US $24.50; UK £10.45.

The first edition of this textbook appeared in 1908, the year that the critic was born. Actually this present edition is only partially authored by Burrows since there are eight other authors represented in the volume (although not shown on the "masthead" (title-page)). The coverage is very broad as indicated by the title, including systematic consideration of Fungi; Spirochetales (formerly placed close to or in the Protozoa; still regarded by some as intermediate between the Bacteria and Protozoa); Rickettsiales; Mycoplasmatales; Actinomycetales; Chlamydobacteriales (PLT organisms; Psittacosis-Lymphogranuloma--Trachoma group, somewhat like the Rickettsiae, but now classed among the Bacteria; believed by some a sort of link between Bacteria and Viruses); animal parasites, such as amebae, flukes, flat and round worms, etc.); Virales or viruses (now generally regarded as giant molecules and not living organisms); as well as the various groups of Bacteria. The conventional concepts of the 4 phyla (divisions) of the plant kingdom have been retained although this is now largely antedated. The text subject matter has been arranged in a good orderly sequence, starting with the history of the discipline, the physics and chemistry of microorganisms, their physiology (growth, metabolism), control with drugs (bactericides, chemotherapy), genetics, taxonomy, the pathogenic microorganisms, epidemiology, the microbiology of water, sewage, milk, and foods, immunology (antigens, antibodies), hypersensitivity, and finally (from Chapter 15 on), the systematic study of the various groups. The general order of these is: Cocci, Bacilli, Vibrios; Brucella organism; Pasteurella; Actinobacillus; Hemophilus; Bordetella; Pseudomonas; Mycoplasma; spore-forming Bacilli; Clostridium; Corynebacterium, Mycobacterium; fungal pathogens; Spirochetes; medical parasites; Rickettsia; PLT organisms; and Viruses. The latter have been arranged in groups mostly on the basis of diseases caused: pox, tumor, herpes,

polio, myxovirus (influenza, etc.), picorna-viruses (enteroviruses and rhinoviruses). hepatitis, adenoviruses, and the arboviruses (=ar(thropod)-bo(rne) viruses). This work reflects the many changes in viewpoint and increases in knowledge in this most important field of science.

GMH

"DIE MIKROSKOPIE DER STAERKEKOERNER" by Alphonse Th. Czaja, Part VI-1 of "Handbuch der Staerke in Einzeldarstellungen (eine Monographienreihe herausgegeben von M. Ulmann)." 136 pp. + 109 figs., 8 color figs. on 2 pls., card cover. Verlag Paul Parey, 1 Berlin 61, Lindenstrasse 44-47. 1969. DM. 32.

This brochure of 136 pages represents the first monograph of volume VI entitled "Die Staerkekorn". The entire encyclopedia when completed will constitute a series of ten volumes. One other issue, its position in the series unclear, has been reviewed by the present reviewer, viz., Seidemann's "Staerke-Atlas" (1966). The order of subject matters is as follows: I. General microscopy of starch grains (granules) from vascular plants, considering those from the Angiosperms, Gymnosperms, and Pteridophytes. II. Special microscopy of starch granules: as carried out by (A) polarization microscopy (B) phase contrast microscopy (C) fluorescence microscopy (D) starch grains as phase objects (E) iodine reactions of starch granules (F) swelling of grains under various conditions (G) swelling in $ZnCl_2$-I_2 (H) Lintnerization of granules (dilute HCl for several days to produce a soluble starch) (I) fermentative dissolution of starch (J) growth of starch granules (K) list of plant families from the taxa of which starch granules have been studied. There are four indices: literature; author; subject; and plant name (scientific names only). From this compilation of subject matters, it is obvious that the book covers important subject matters and would be a most necessary work in any laboratory where starches are studied.

GMH

"THE STORY OF CHEMICAL INDUSTRY IN BASLE" published by CIBA Limited on the occasion of its 75th anniversary. 234 pp. Olten and Lausanne (Switzerland): Urs Graf Publishers. 1959.

This fine quarto volume would be classified as an art work with its magnificent colored illustrations and splendid book construction. It covers the development both of dyestuffs and pharmaceuticals, and does not limit itself to CIBA but also very generously includes information about its competitors in Basle, viz., Sandoz, Geigy, and Hoffman-La Roche. This represents an important contribution to the history of natural and synthetic chemicals over the past three quarters of a century.

GMH

"HANDBUCH DER LEBENSMITTELSCHEMIE. BAND VI: ALKALOIDHALTIGE GENUSSMITTEL, GEWUERZE, KOCHSALZ" by J. Schormueller (editor) XXIV + 770 pp., 265 figs., many tabs., Springer-Verlag, Berlin-Heidelberg-New York. 1970. $68.20 (bound).

The entire encyclopedia (or handbook) covers 9 volumes (Baende) bound in 13 volumes (Teilen) covering foods, beverages, spices, etc. Each volume includes a distinct segment of interest and may be purchased separately. (Briefly the coverage is: vol. 1: food components; 2: analysis; 3: animal foods; 4: fats and "lipoids:; 5: carbohydrates, fruits, etc.; 6: the present volume; 7: alcoholic beverages; 8: water and air; 9: packaging, disinfectants, etc.). In the reviewed volume, essentially on non-alcoholic beverages, tobacco, and spices, the following topics are taken up (the figure in parentheses indicates number of pages covered): Coffee (95) with substitutes and additives (43); Tea (37) and tea substitutes (22); Maté and other South American caffeine beverages (5); Kola (7); Cacao and Chocolate (100); Tobacco (38); microstudy of coffee and substitutes (46), of cacao (20), of tobacco (12); spices (185); condiment or food acids (citric, etc.) (17); spice essences and extracts, also substitutes and artificial spices (4); aromatics and "essences" (concentrated flavors); (8); cooking (or table) salt (26); vinegar (54); artificial sweeteners (21); notes on legal requirements for foods (18). Subject index (18). The authorship is listed on page XXIV and includes 11 German scientists, 1 Swiss, and 1 Dutch scientist. A large number of spices is taken up in considerable detail. These include ginger, galanga, zedoary, turmeric, calamus, lovage root, cinnamon, canella, clove bark (black cinnamon), massoia bark, laurel leaves, lemon-grass, thyme, melissa, and at least 51 others. As usual, typography, figure reproduction, clarity, and binding are of the best. The binding of dark green cloth is that seen in so many of Springer's encyclopedias. Because of the large number of figures much of the volume is printed on glossy paper. The present volume should be able to take the place of a valuable work of the past now long since out of print: J. Moeller: "Mikroskopie der Nahrungsund Genussmittel" (1885, 1905, 1928). Although the price for the volume may seem high, when one takes into account the comprehensive scope of the work, its elaborate illustrations, its precision, its profusion of references (both books and journal articles) at the end of each chapter, and its general utility in several areas, the price will certainly be accepted as most reasonable. Indeed the book is a bargain!

GMH

"LEXIKON CHEMISCHER KURZBEZEICHNUNGEN VON ARZNEISTOFFEN: NATIONALE UND INTERNATIONALE KURZNAMEN". (Lexicon of chemical short names of medicinals: national and international short names.) Compiled and annotated by the Medicinals Bureau of ABDA with collaboration of University Lecturer Dr. K. Schriever, München, pp. 1 423. Govi-Verlag GmbH, Pharmazeutischer Verlag, Frankfurt am Main, Germany. 1968. Price not given.

The plan of this work is very simple and direct since, except for four pages of explanatory text and a terminal index of preparations, the content is entirely made up of a tabular arrangement of therapeutic chemical compounds arranged in a single alphabetic sequence. The first entry is Acebrochol(um) and the last one Zylofuramin(um). (It is obvious from this compilation how strong the Latin or Latinized drug names are in central Europe.) A brief introductory statement and a list of abbreviations (but not including "ABDA") precede the tabulation. For each compound, the International Non-Proprietary Name (INN) is given, with the Latin form in first place; arrangement is alphabetically by the initial letter of these compound names. The Latin and non-Latin INN are printed in bold-face type. In many cases, the INN titles are followed by U.S. Adopted Names (USAN), French Common Names (Dénomination Commune Française, DCF), Scandian Pharmacopeial Names (Nordisk Farmakopénaevn) (NFN), British Approved Names (BAN), or by names used in the British, German, Austrian, Belgian, Danish, French, Swiss, Hungarian, International, Norwegian, Swedish, or United States Pharmacopeias, or in the British Pharmaceutical Codex, National Formulary (USA), or Scandinavian Medical Codex (Codex Medicamentarius Scandinavicus). The left side of the page is also used for listings with cross references, thus for example, Acide glycyrrhétinique is referred to Enoxolonum. The middle of the page is occupied with the chemical name and a structural formula, while--on the right side--the preparations if any are listed, showing the proprietary name, the manufacturer's or dealer's name, and the country. Two sections of text appear on pages 405-6:

(1) Procedure for the selection of the recommended international short designations for pharmaceutically used substances; and (2) General guide-lines for formation of international short designations of pharmaceutically used substances. The index refers the proprietary name to the proper generic or common name.

GMH

"PHARMACOGNOSY". Lecture 1: Jungle search for new drug plants in the Amazon; Lecture 2: Native narcotics of the new world; Lecture 3: Botany attacks the hallucinogens. Pharm. Sciences, 3d Lecture Ser. 1960: Univ. of Texas. 137-85, 19 figs.; 1961. (Reprinted in Texas J. Pharm. 2: No. 3; 1961) by R. Schultes.

Following a biographical note on the author, Richard Evans Schultes (with portrait), there is presented a brief outline abstract of the first lecture, the second and third lectures being given *in extenso*. These are interesting presentations with popular appeal. Lecture 2 deals with the New World (mostly South American) delirifacients (*Datura* spp., ololiuqui, payote, mescal, sacred mushrooms, yakee, yopo, coca, caapi (etc.), rape dos idios, etc. Represented is an expanding area of knowledge with much yet to be learned about native uses of these materials. Lecture 3 takes up a more detailed discussion of two of the materials in lecture 2: the Mexican sacred mushrooms and the hallucinogenic products from fam. *Malpighiaceae* used in northern South America, caapi (ayahuasca, yaje), etc. Although the latter have been known for a century, yet still much remains unknown about their botanical origins. The mushrooms of Mexico used as delirifacients were known to the early immigrants 400 years ago, but our sketchy knowledge on these was not enlarged until about 20-25 years ago, and much research - botanical, chemical, and pharmacological - remains to be done in this area.

GMH

"GENERAL PHARMACOLOGY" by A. J. Clark, Band IV of Handbuch der experimentellen Pharmakologie (Handbook of experimental pharmacology) founded by A. Heffter. Ergaenzungswerk, edited by W. Heubner and J. Schueller, ii + VI + 228 pp., 79 figs., 28 tabs., cloth. Reprint of original edition, Berlin (1937). Springer-Verlag, Berlin-Heidelberg-New York. 1970. DM 76,--; US $20.90.

The author of this outstanding title was a British pharmacologist who lived from 1885 to 1941, dying aet. 56 years. Alfred Joseph Clark was Professor of Materia Medica at Edinburgh University 1926-41. He is best known for his "Applied Pharmacology" which went through several editions; he also authored "Mode of action of drugs on cells" and "Comparative Physiology of the Heart". (For biographic information, see World Who's Who in Science, ed. 1, p. 339;1968). As in the case of general physiology, general pharmacology deals with the chief principles of the science as applied to all living organisms (animal and plant) without entering into detailed consideration of specific organisms or specific drug agents; these may of course be used as examples to illustrate ; —

a general statement or idea, but the object is to discuss principles and comcepts not specifics. More than that, the objective throughout in this work has been to interpret the reaction of drugs in the living organism in terms of physical chemistry. The cell is first considered as a physico-chemical system, then the components of the cell are studied--the proteins and enzymes particularly; the relationship of drug concentration to tissue reactions (2 chapters); the kinetics of drug reactions; time-drug concentration relationships; individual variations in response to drugs; variation in populations of animal organisms (including humans); drug antagonism and drug synergism; various theories of drug action; and the quantitative aspects of chemotherapy. Chapter 21, "Conclusion", sums up the volume in a brief 2 1/2 pages. The original work was published as volume 4 of the supplement to Heffter's Handbook in 1937; in this reprinting it retains its place as Supplement Vol. 4. The reprinting is done with good quality of reproduction; there is nothing apparently to be criticized. The book is equipped with a table of contents and at the end the author and subject indices. All references are given in footnotes; thus, there is no separate bibliography, which is now the popular way of presenting references. Undoubtedly this book is a most valuable one to the pharmacologist, physiologist, and physical chemist.

GMH

"SUGAR ESTERS: PREPARATION AND APPLICATIONS" by J. C. Colbert, x + 310 pp. Noyes Data Corporation, Park Ridge, New Jersey (USA); London, England. 1974. $36.00

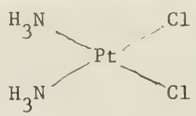
This book differs from most text books in that instead of the data representing a summary of the journal (chiefly), book, and pamphlet literature of the world, it is a résumé of the United States patent literature. A patent by its very nature (Latin, patens, standing open) must reveal complete details: hence, this volume is replete with factual, practical, and specific information on the preparation and uses of sugar esters as developed by laboratory and factory experimenters. An added benefit for this book is that by its removal of chaff (legal phrases), the nub of truth (representing the actual concrete details which are of value) is made available, and hence this compilation is useful in searching the patent literature of the field. It should save a great deal of time for those who are engaged in this field of patent law. The value of this specialist volume is especially great because the American patent literature is the largest and most comprehensive collection of technical/scientific data in the world. A number of sugar esters occur in nature, thus for example some of the tannins are combinations of sugars with polyphenols (like gallotannin); some enzymes of phosphoric acid and sugars serve as coenzymes; and so on. Sugar itself of course is not

only an important food material but it is also important as a chemical raw material, in the manufacturing of industrially used products. Some of these compounds are quite simple (as sucrose octa-acetate, used as a bitter agent), others complex. This book for a technical work is unusual in not having a terminal subject index; instead the table of contents in front is sufficiently detailed to serve adequately in its place. At the end of the volume are company, inventor, and patent number indices.

GMH

"PLATINUM COORDINATION COMPLEXES IN CANCER CHEMOTHERAPY" by T. A. Connors and J. J. Roberts, XII + 199 pp., 93 figs., 81 tabs. (Royal Cancer Hospital, London). Recent Results in Cancer Research (RRCR) vol. No. 48. Springer-Verlag Berlin, etc. 1974. Cloth hard-back, $27.80.

As with nearly all other volumes of this series, the text is in English. Following the preface, there are 17 contributions from individuals in England (7), USA (8), Hungary (1), and Czechoslovakia (1). The papers of these scientists were presented at a Second International Symposium on the subject held at Oxford in April of 1973. First we had the gold treatment of arthritis, now another precious metal is involved in the therapy of cancer, platinum in inorganic complexes. The cis-platinum (II) diammine dichloride (PDD) (formula) is the compound mostly used in experimental studies. The diammines are conceived as metal salts with two molecules of ammonia. This complex has been shown to have cytostatic (growth-inhibiting effect) with alkylating-like properties. Whereas the metal alone is toxic, by having the platinum "locked in a tight ligand sheath", the general toxicity can be reduced and control over specific situations can be made possible. The clinical use of platinum complexes is still some distance away but good progress is being made towards a practical application. After all, the anti-tumor activity of Pt complexes was only discovered in 1971.



GMH

"THE SCIENCE BOOK OF MODERN MEDICINES" by Donald G. Cooley Subtitle: The amazing story of a titanic revolution in chemotherapy and other allied sciences that is beginning to reveal the hidden secrets of life and new ways to improve health and human welfare. Pocket Books, Inc., 1 W. 39th St., New York 18, NY. IX, 228 pp. 1963. $0.50 paper bound (free from Pharm. Manufacturers Assn. 1155-15th St. N.W., Washington, D.C. 20005). (Cloth bound ed., Franklin Watt, Inc., N.Y. $4.95).

Interesting and informative book for the layman.

GMH

"FUNGI - POLYPORACEAE I (resupinatae); MUCRONOPORACEAE I (resupinatae) (Grzyby) (TT 70-55021)" by Stanisław Domański, 362 pp., 63 pls ("tables"), 78 figs. National Technical Information Service, Springfield, VA 22161. 1972. $10.00 (domestic); $12.50 (foreign).

This work was translated from the Polish by Foreign Scientific Publications, the original book "Grzyby" (meaning Fungi) having been published in Poland in 1965. The work covers the two families Polyporaceae and Mucronosporaceae, covering those members with resupinate (lying flat on substrate with hymenial layer on the outside) fruit-bodies. The chief of three groups throughout the volume consists of organisms found in Poland (designated by numbers without parentheses); the second group are those fungi not yet found in Poland but very likely to be found there (shown by numbers in parentheses); while the third group are those which may possibly but are unlikely to occur in Poland (indicated by having no number). Descriptions, drawings, discussion and opinions, references, uses, etc., are given for each taxon. An important feature of the book are the plates at the end, of which there are two sets, the second set being made by a better reproduction process. Preceding the plates are an index, glossary ("vocabulary"), and bibliography. There are 236 pages of text, the balance being the plates.

GMH

"FUNGI: POLYPORACEAE II (pileatae), MUCRONOPORACEAE II (pileatae); GANODERMATACEAE; BANDARZEWIACEAE; BOLETOPSIDACEAE; FISTULINACEAE (TT 70-55022)" by S. Domański, H. Ortos, and A. Skirgietto, 330 pp., 27 pls. ("tables"), 109 figs. National Technical Information Service, Springfield, VA 22161. 1973. $10.25 (domestic); $12.75 (foreign) hardback.

This is actually the third volume of a set; vol. 1 having been by Skirgrello and on the Boletales (1960) and vol. 2 the work on Polyporaceae by Domański (above). The present volume was translated from the Polish work published in 1967. This group of fungi is important economically in Poland because of the great amount of wood damage. There are many keys, and for each species synonymy, description, habitat, distribution, distinctions, and figures. No novelties were noted in either volume. The plants described and figured were collected in 1955-63. An error appears in the second volume, p. 187, under Fomitopsis officinalis: consumption of the fruiting body does not cause perspiration, rather it is used as an anti-perspirant.

GMH

"GETREIDEENZYME: Eigenschaften, Analytik, Bedeutung" by M. Rohrlich, 135 pp. + 53 figs. + 1 col. pl. + 47 tabs., Verlag Paul Parey, Lindenstr. 44-47, 1 Berlin 61. 1969. paper-card bound DM 38,--.

The enzymes present in the fruit and seed tissues of what passes for the grain of the cereal grasses prove to be of extraordinary interest and importance as the story unfolds in the pages of this brochure. Dr. Matei Rohrlich is director and professor at the Federal Research Institution for Grain Processing at Berlin, and without question is in an ideal position to discourse on this subject; he is a co-author of a four volume work, "Die Getreide", now in course of publication. In the present work, the introductory chapter gives much fundamental information on enzymes; then follow chapters on the properties of cereal enzymes and their distribution in the caryopses (or grains), enzymes in ripening and germinating grains, the analysis of grain enzymes, enzymes in yeast dough and sour dough (or leaven), with a final chapter on the technical significance of grain enzymes. The literature references are all placed together by chapter at the end of the volume, followed by a subject index. No effort has been spared to make the text as lucid and credible as possible by means of graphs, figures, tables, and so on.

GMH

"RÖMPP CHEMIE LEXIKON", Ed. 6, 4 vol., XII, 7860 col. (= 3930 pp.) (2 columns per page), 64 pp. advertising matter; many figs., Franckh'sche Verlagshandlung, W. Keller & Co., Stuttgart, Germany. 1966. DM. 429.--(approx. $108.00).

"The Roempp" is truly a great reference work, tremendous in concept, unique in its offerings to the many branches of chemistry. This set of four volumes is an excellent example of the special gifts of the Teutonic peoples--in this case demonstrating their great industry and accurate recording of data in one of the most difficult and complex fields of human activity. The wide appeal and utilization of these volumes in the world of science and industry is reflected in the many categories of periodicals where reviews, all mostly laudatory, have been published as noted in advertising booklets. These fields include the chemical industry and profession itself, and those industries concerned with the manufacture of pharmaceuticals, starch, fuels, dyes, beer, plastics and so forth. It is most difficult to review a work of such breadth and scope. Perhaps a cataloging of the kinds of information contained would be most practical for a person considering purchase. The following subjects (among others) are covered in this encyclopedia: (1) Classes of compounds (ex., carbides; carbohydrases); (2) individual

compounds of natural origin (ex., cellulose; quinic acid); (3) individual synthetic compounds (ex., chloromethyl methyl ether; chlorpyridine); (4) substances such as mixtures (ex., soils; essential oils); (5) processes (ex., ethylation; Eschweiler's reaction); (6) phenomena (ex., respiration; choleresis); (7) compendia (ex., German Pharmacopeia (D.A.B.); but not the British Pharmacopoeia); (8) biographies (ex., Walter Bothe; Jean Baptiste Boussingault); (9) trade marked articles (ex., Celathion; Derrisol); (10) therapeutic terms (ex., derivants; disinfection); (11) chemical terms (ex. des; exo-); (12) abbreviations (ex., Diss. for Dissertation; CPL. for Chemicals Procurement Laboratories, Inc.); (13) commercial firms (ex. Ciba; Chemstrand (Decatur, Ala.)); (14) commercial sources of various materials (ex., Cinnamyl acetate is available from 5 firms, which are listed along with the prices per 100 g.); (15) references (ex., under lemon oil, 2 book references are given; under "chemical laboratories" scores of book and journal references are given); (16) natural (crude) plant, animal, and mineral products of specific type (ex., elemi; beeswax,; limonite); (17) methods (procedures) (ex., aquametry; Debye-Scherrer X-ray method); (18) apparatus (ex., Autrometer; distillation apparatus); (19) devices (ex., Bunsen valve; hydrometer); (20) units (ex., barrel; bushel); (21) serials (ex., Bibliography of Chemical Reviews; Chemical Abstracts); (22) professional and research organizations (ex., Chemical Society; on columns 1075-86, a list of research and consultation institutions). There are "chapters" on chemistry dictionaries (foreign language), institutes, etc. Incorporated in many of the definitions are data on commercial production, history, the literature, uses, etc., etc.

For English-speaking chemists or other consultants, two special provisions have been made: (1) at the end of each important definition, there is given one or more equivalent English expressions. (2) At the end of volume 4, there will be found a useful index of 25,000 (plus) English words and phrases, with a notation of the column(s) of the text where they occur.

This great work first appeared after the end of World War II (1947), actually the labor of a single individual, Professor Dr. Hermann Roempp, recently deceased. The new editor is Dr. Erhard Uehlein. (A necrology to Roempp appears in volume I, pp. vii, viii.) A list of the persons and companies who contributed articles for this encyclopedia appears on pp. vi, vi. In the reference scientific library, in the business office, in the professor's office, this set of four great volumes should always be available. For the chemist, Roempp will lie alongside Merck's Index, Webster's English Dictionary, and DeVries' German-English Science Dictionary--ever ready for use.

GMH

"CHEMIE LEXIKON" Vollig neu bearbeitete und erweiterte sechste Auflage. Band II: F-L, by Hermann Römpp, V + columns 1949-3806, many figs., and tabs., Franckh'sche Verlagshandlung, W. Keller & Co., Stuttgart, Germany. 1966. Price of set of 4 vols., DM.429,--.

In this second volume, the alphabetical treatment of things chemical is continued with the alphabetic initialed words from "F" through "L". The utility of the encyclopedia may be illustrated by the success enjoyed in searching for information on "Fulvene". Roempp showed over half a column devoted to this group of hydrocarbons, including graphic formulas of some members, the origin of the name, its basic meaning, the English title, and three important references. In contrast, a search for "fulvenes" in several recent American textbooks of organic chemistry was rewarded by not even a mention of these important compounds. The Roempp work is of everyday utility, maybe the most useful book in my library, with the possible exception of Merck's Index. The following terms could not be discovered in volume 2: lignan; glucoluteolin; HLB value (hydrophile-lipophile balance). Indulin (NOT Induline) is a trademark of West Virginia Pulp and Paper Company (Industrial Chemical Sales Division), New York City, not of "Ind. Chem. Cabs." as given. Such occasional omissions or errors are difficult to find, however, in this extraordinarily useful reference work.

GMH

"FLORA OF THE PRAIRIES AND PLAINS OF CENTRAL NORTH AMERICA" by P. A. Rydberg, 2 vols.: Vol. I: vi, 503 pp. 337 figs.; Vol. II: iv, pp. 504-969, 263 figs., Dover Publications, Inc., New York. 1971 (1932). $5.00 each.

Unabridged and corrected republication of the original edition, which was in a single volume.

The fact of its republication would indicate that this work has merit in defining the flora of the central part of North America. A summary of numbers of taxa (pp. 902-3) shows that the entire work contains 1066 genera with 3988 species of which the dicotyledons show the largest number (2932 species), the monocots ranking second, the pteridophytes third, and the gymnosperms least with 19 species. While this edition is a republication, corrections have been made so that this work is an improvement over the original. A somewhat unusual feature is the use of English common family names as a running title on the top of the right-hand pages, such names as Bunch-flower Family (Melanthiaceae). Rydberg was for nearly a third of a century Curator of the Herbarium of the New York Botanical Garden, at that time the largest herbarium in America and one of the largest in the world.

GMH

"MIRAGE OF HEALTH: UTOPIAS, PROGRESS, AND BIOLOGICAL CHANGE" by Rene Dubos, 235 pp., World Perspective Series vol. XXII. Anchor Books, Doubleday & Co., Inc., Garden City, New York. 1961. $0.95.

The author effectively deflates many of the grandiloquent claims made for medical science in the field of health improvement. Natural trends in the development by populations of immunity to various diseases have usually been overlooked and all of the progress made in disease combating attributed to the use of vaccines, antitoxins, or antibiotics. The text is both readable and most informative. (A few errors were noted. Thus, on p. 132, aconite is not a plant alkaloid but rather an alkaloidal plant. On page 100, lathyrism is not produced by chick peas (Cicer arietinum) but by species of Lathyrus, including sweet pea, flat pea, Tangier pea, etc. On the same page, dicumarol and not coumarin is the cause of cattle hemorrhagic disease, and neither of these compounds is steroidal.)

GMH

"EDUCATORS GUIDE TO FREE GUIDANCE MATERIALS , A Multimedia Guide" compiled and edited by Mary H. Saterstrom and Joe A. Steph. Educators Progress Service, Inc., Randolph, WI 53956. 9th Annual Edition. XXIX + 254 pp. 1970. $8.75. - 10th Annual Edition XVIII, 252 pp., 1 portr. 1971. $8.75.

The 1970 issue includes 571 films; 64 filmstrips; 59 tapes, scripts, and transcriptions; and 288 miscellaneous materials (bulletins, pamphlets, charts, posters, serials, and books). We have here a very useful reference book for use in and outside of the school. One feature of this publication is indicated in the publisher's foreword on page III of the Guide. Reprints of the article, "The Reporting Process as a Component of Self-Competency," by Dr. Gail F. Farwell, will be furnished free to educators and librarians who ask for them. Each edition updates the previous one. Most of the sheets in this useful compilation are printed on one side only. Subject matters covered include: career planning materials; social-personal materials; responsibility to self and others; and the use of leisure time. The text is classified according to media types as follows: films; filmstrips and slides; tapes, scripts, and transcriptions; printed materials (pamphlets, leaflets, etc.).

GMH

"FLORA TOXICA DE PANAMÁ" by Novencido Excobar, 280 pp., 52 figs. Editorial Universitaria, Seccion: Ciencias, Panama. 1972.

Without question, the flora of tropical America is one of the richest in the world, if indeed not the richest of all.

Among these many taxa, it is reasonable to suppose that quite a large number are poisonous. The author has discussed 199 poisonous plant species of Panama arranged quite logically into their respective families, of which there are 56. These are placed in an alphabetical sequence from Amaryllidaceae to Zygophyllaceae, or in other words "from A to Z." The data given in each monograph includes scientific and vernacular names, brief notes on distribution and description, uses, and toxic properties, often with a photograph of the plant. In addition to the systematically arranged plant information, the introduction includes a classification of types of poisoning by plants with lists of plant examples under each. Also included are plant poisons (or barabascos), insecticidal plants, plants toxic to live stock, and rodenticidal plants. The chemical nature of the various poisons is also summarized. At the end of the volume are a glossary, indexes to scientific and vernacular names, and a bibliography. The volume bears a preface by the Director and Curator, Economic Botany of the Botanical Museum of Harvard University, the mentor of the author.

GMH

"COMPARATIVE MORPHOLOGY OF VASCULAR PLANTS" by Adriance S. Foster† and Ernest M. Gifford, Jr., xi + 751 pp. Ed. 2. W. H. Freeman and Co., San Francisco, Cal. 1974. $17.00.

In this work, we have a fairly comprehensive account of the structure of all major groups of the vascular plants. The term "morphology" is here used to include both morphology per se (the gross structure of the plant part) and anatomy or histology (the microscopic structure of the plant part). The subject matter includes organography, reproductive mechanisms, morphogenesis, etc. The audience anticipated (and achieved in edition one) is that of upper division and graduate college students. The authors frankly admit that no attempt was made to cover all of the truly voluminous literature published worldwide in this field but they have endeavored to cover the major advances in our knowledge and to provide references to the most important of the many books and papers published in the area. A considerable number of changes have been made in the text, as for instance the inclusion of ultrastructural details of some plant parts as revealed by the electron microscope. Such studies were not usually available at the time of the first edition of the book in 1959. The first six chapters of the book are rated as "orienting" chapters which summarize present knowledge on the chief morphological features of the tracheophytes (spermatophytes and pteridophytes) as a whole, the general organ structure and anatomy of the vegetative sporophyte, and the development and structure of sporangia, gametangia, and embryos. The following fifteen chapters of the text go into greater detail but are best studied in connection

with these first review chapters. As would be expected, the progression in evolutionary position of the various plant groups is mirrored in the order of the chapters: starting with Chapter 7, the earliest vascular plants (Rhyniopsida, etc.) and proceeding through chapters on the Psilopsida, Lycopsida, Sphenopsida, Filicopsida, Eusporangiate Ferns, Leptosporangiate Ferns, Gymnospermae, Cycadopsida, Coniferopsida (2 chapters), Gnetopsida, to the final three chapters on the Angiospermae. The book is well made and attractive.

GMH

"OCCURRENCE OF PSYCHODELIC SUBSTANCES IN SOME INDIAN MEDICINAL PLANTS" by S. Ghosal (Abstract). Planta Medica 21(2): 200-9. 1972.

Review of 18 publications of the author and collaborators from 1967 to date on 25 Indian plant species of families Leguminosae, Gramineae, and Malpighiaceae. Included are the methods of extn. and isolation, plant species and plant part sources of 22 indole alkaloids, the pharmacological testing methods, and the chem. of the compounds. The more strongly polar type of alkaloids appeared to accumulate in the extreme ends of the plants, thus, the quaternary amines in the roots and the tert-amine oxides in the fruits. Total alkaloid fractions and individual alkaloids tested indicated two types of behavior: facilitated response to serotonin on isolated rat uteri and gross behavioral conduct in rats and mice. N,N-diMe tryptamine, 5-Methoxy-N,N-dimethyltryptamine, 5-methoxy-N-methyl-tryptamine, bufotenine, harmine, (+)-tetrahydroharmine, and (+)-5-methoxytetrahydroharman (new natural base) elicited strong behavioral effects in rats and mice, viz., tremors, hyperactivity, salivation, convulsions, etc., which were almost completely antagonized by pretreatment of animals with chlorpromazine. The alkaloids also reversed the reserpine-induced sedation of mice. The metabolism of indole-3-alkylamines and the role of aromatic β-carbolines as psychotropic agents is discussed. 38 references.

GMH

"A FLORA OF NELSON COUNTY, KENTUCKY, WITH A SELECTED LIST OF ECONOMICALLY IMPORTANT PLANTS" by Sister Rose Agnes Greenwell, Xiv, 205 pp., 1 map. Nazareth College, now called Catherine Spalding College, 851 S. 4th St., Louisville, Ky. 1935.

According to Blake and Attwood (Geogr. Guide to Floras of the World, vol. 1, p. 183), the text of this was published as No. 20 in Cathol. Univ. Amer., Biol. Ser., but without indication of this publication as a separate by Nazareth College. The geography, topography, geology, drainage, and botanical history of the County are discussed, followed by

keys to and treatment of 863 spp. of Pteridophyta and Spermatophyta known (in 1935) as native to this area. Also included are glossary, authors' names and life dates, brief bibliography, and index. It will be of interest to know that this basic work is still available; under many families, there is brief mention of economic values.

GMH

"CHEMISTRY AND BIOCHEMISTRY OF ABSCISIC ACID" by D. Gross, Pharmazie 27(10): 619-30. 1972.

Abscisic acid (I), a native plant growth inhibitor with a complex activity spectrum, has been intensively studied in recent years, especially as to its effect on resting bud formation and growth, seed germination, tuber formation, flowering and abscission processes, transpiration, nucleic acid synthesis, and other metabolic processes. Its close interaction with other growth regulators (auxins, cytokinins, gibberellins) are of much interest. In view of the low toxicity of I, practical uses are of interest. Analogs of I are also of interest because of the potentially detrimental effect of the high metabolic activity of I. The discovery, isolation, structure, chemical properties, occurrence, synthesis, and biosynthesis (carotenoids as possible precursors) of I are reviewed in depth. 152 references.

GMH

"SPIEGEL DER ARZNEI: URSPRUNG, GESCHICHTE UND IDEE DER HEILMITTELKUNDE" (The Mirror of Medicine: Origin, History, and Concepts of Medical Science) by Hans Haas, viii + 256 Seiten. Ganzleinen, Springer-Verlag, Berlin. 1956. 19.80 DM.

The author endeavors to show that the history of medicine properly understood and evaluated (that is as a history of ideas as well as of discoveries) can give us a key to an understanding of the present concepts and objectives of the science. The two chapters of most interest to pharmacognosy are those entitled "Medicinal Plants and Therapy" and "Poisons and Therapy". These sections dwell on the medicine of the remote past, of the ancients (Theophrastus, Dioscorides, et al.) and of the Dark Ages (Albertus Magnus et al.), on the days of the herbals, of indigenous and exotic medicinal plants, of the study of medicinal plants in the renaissance period up to modern times, the vitamins first from natural sources until now when all have been synthesized, whole drug vs. pure substance therapy, and the evaluation of various forms of medicine. Under poisons, many potent medicinals are considered, such as strophanthin, physostigmine, strychnine, curare, and the curariform agents, ergot as a poison and as a medicine, thyroid-inhibiting drugs, dicumarol, fluorine, urea, etc. Of course,

other chapters explore the use of and developments from crude drug therapy. Thus, in the chapter on empiricism and therapy, there are discussed various addictive, habituating, and beverage materials which are considered part and parcel of the field of pharmacognosy; also, camphor, digitalis, ipecac, cinchona, chaulmoogra, and other drugs are considered. The book has made a beginning, and a successful beginning, at the formulation of a philosophy of modern medicine.

GMH

"PHYTOCHEMICAL METHODS: A GUIDE TO MODERN TECHNIQUES OF PLANT ANALYSIS" by J. B. Harborne, X + 278 pp., 54 figs., 51 tabs, Halsted Press, New York and Chapman and Hall, London. 1974. $15.50.

This volume deals with techniques applied to the analysis of plant materials, and is intended to be of service to students and practitioners of biochemistry, pharmacognosy, food science, and natural products organic chemistry. The book starts out with general discussions of plant analytical methods, including extraction, isolation, separation, and identification, then proceeds to the more detailed treatment of separate groups. These include the phenolic compounds (including many plant pigments); the terpenoids (volatile oils; diterpenoids and gibberellins, triterpenoids and steroids, carotenoids); organic acids, lipids, and related compounds; nitrogen compounds (including amino acids, amines, alkaloids, CN glycosides, indoles, purines, pyrimidines, cytokinins, chlorophylls); sugars and derivatives; and macromolecular substances (nucleic acids, proteins, polysaccharides). The text is clearly printed, in a large type face, with many references at the end of each chapter. This text can be recommended as of great interest and utility in the various areas where phytochemistry is applied.

GMH

"DIE DEUTSCHE APOTHEKE: BILDER AUS IHRER GESCHICHTE" by Wolfgang-Hagen Hein, VIII, 231 S., 110 abb., 19 x 27 cm. Deutscher Apotheker-Verlag, Stuttgart, Germany. Clothbound. 1960. DM. 45.--.

This splendid "picture book" follows the pattern of many such works in diverse fields which are rightfully so popular at the present time. Following a textual introduction, there appear many full page plates, opposite each of which is a page of commentary, telling something in this case about the creation, the creator, the date of creation, the special qualifications which render the item of particular interest, and so on. As usual, the source of each illustration is identified in alphabetical presentation at the back of the volume. An unusual feature of this particular work is a

tabulation of references at the back which deal with the subjects of the illustrations. The connection is shown by inserting the page number after the reference. Thus, an article by L. F. Bley is cited in the Archiv der Pharmazie for 1844, with reference to the text page 184, which tells about the phyto- and pharmacochemist Brandes in connection with his grave monument shown on the opposite page. There is also a listing of texts on pharmaceutical history which are liberally supplied with illustrations. A listing of locations of the various items shown is also included, item by item. There is a great variety in the sort of things illustrated in these splendid black and white photographic reproductions. Thus, we find here painted portraits, paintings of scenery, photographic portraits, pictures of shelf-ware, glass bottles, ruins of drug stores (World War II destruction), old pharmacies (apothecaries) (both exteriors and interiors), pharmaceutical apparatus (such as presses, mortars and pestles, etc.), medicinal plants and crude drugs, book plates, title pages of historically important volumes, statues and bas-reliefs, reproductions of wood-cuts, ancient manuscripts, pharmaceutical manufacturing plants, medals, pharmaceutical schools and institutes, laboratories, mosaics, monuments, and so forth. This volume so rich in pharmaceutical lore would make a splendid gift to a professional person, such as a pharmacist or physician, even though his knowledge of the German language were deficient, since many of the pictures can be understood with a bare minimum of knowledge of the language.

GMH

"DIE ANTIDYSKRATISCHE BEHANDLUNG ALS BASISTHERAPIE CHRONISCHER KRANKHEITEN" by Dr. med. Heinrich Honegger, 272 Seiten, in Leinen. Karl F. Haug Verlag, Ulm/Donau. 1959. DM 30--.

"Antidyscratic treatment as a basic therapy for chronic diseases" is a title which requires some explanation. "Dyscrasia" is defined in this book as a "blood contamination" or a "lymph corruption" and is based on the old humoral-pathological concept. (This use of dyscrasia is quite different from that ordinarily understood, in which a foreign toxic substance (as from a parasite or infection) enters the blood stream.) Although the term in this newer significance was introduced by the author in 1936, yet it had been used earlier by such celebrated scientists as Virchow, the father of pathology (who spoke of a cancer dyscrasia) and the great surgeon Sauerbruch, who found the concept of humoral pathology useful. To "total dyscrasias" are attributed many of the most serious diseases of the human body, such as cancers, pernicious anemia, diabetes, epilepsy, etc. The author advocates the use of homeopathic remedies, including many minerals (such as antimony) and crude drug (plant and animal) preparations,

usually in combinations. No modern synthetic drugs are discussed. Physical therapy also is advocated, such as baths, massage, insolation, etc. The author, a practitioner of medicine at am Neckar Esslingen, has written this text (he says) for the physician in practice, and he claims it will supply information to fill a serious gap in the medical literature, the lacuna that exists in the therapy for many chronic diseases. In the absence of any really helpful technics of treatment, the author claims his methods will be distinctly helpful although he makes no claim for specific therapy. The author contends that the use of analgesic drugs to modify pain and fever is not basically a healing process, but only a palliative rather than a fundamental benefit to the sick body.

GMH

"SPECIFICATIONS FOR THE QUALITY CONTROL OF PHARMACEUTICAL PREPARATIONS: INTERNATIONAL PHARMACOPOEIA", second edition, XXXVI + 906 pp., 14 tabs., 15 figs., World Health Organization, Palais des Nations, Geneva, Switzerland. English edition. (There is also a French edition.) 1967. $18.00; Sw. fr. 54.--.

A rather surprising feature of this second edition of the Ph. I.-II is the fact that this title has been subordinated to that shown in the first line above. The cover (front and spine) of the book does not bear the title of pharmacopeia. However, the contents within the covers always refer to the text as International Pharmacopeia. No explanation for this rather remarkable titling is given as far as could be found; however, it may well be that the compilers felt that it would be unwise to give the impression that this work is to serve in the capacity of a regular pharmacopeia, hence the masking of the name. A comparison of editions one and two would be of some interest. The first edition carried the following monograph text pages: vol. 1 250 pp.; vol. 2: 215 pp.; supplement (1959): 103 pp.; Annexes: 8 pp.; total for ed. 1: 576 pp. Ed. 2: 604 pp. Hence, even though it might have been thought that the 3 volumes of ed. 1 contained a larger amount of drug monograph text, such is not the case. To make the difference even greater, the type face in the second edition is smaller and there are more lines per page (49 vs. 46 in ed. 1). Quite a few new monographs are included in the present edition that were not in the first: Acacia; ampicillin; bacitracin; cloxacillin; cortisone acetate; cycloserin; griseofulvin; levo-thyroxin sodium; liothyronine sodium; meticillin sodium; nafcillin sodium; neomycin sulfate; noscapine; novobiocin; nystatin; oxacillin; peanut oil; sesame oil; pheneticillin; phenoxymethyl penicillin; predinsolone; prednisone; propicillin; psyllium seed; reserpine; senna leaves and fruit; vancomycin; viomycin; and warfarin, besides many more. A little less than one-third of the book is made up of appendices and index. These appendices are devoted mainly to

technics used in assays. The volume "Specifications for reagents mentioned in the Int. Phar." (1963) is still applicable to the present edition. When specifications are not included in that work, they are given in the Ph. I.-II. ** Without question, the new International Pharmacopeia will be of invaluable service in uniformizing and otherwise improving the content of the 35 or so national pharmacopeias of the world. (Available from book dealers throughout the world who handle WHO publications.)

GMH

"FOLK MEDICINE: A VERMONT DOCTOR'S GUIDE TO GOOD HEALTH" by D. C. Jarvis, M.D., ix, 182 pp. Holt, Rinehart and Winston, 383 Madison Avenue, New York 17, N.Y. 1958. $2.95.

Dr. Jarvis' book was read with mixed feelings. The writer is a good man obviously sincere, who has devoted a lifetime to the study of his patients, apparently not always with the benefit of the very latest gadgets and of the proprietary drugs developed by the big drug houses. Much of his folklore is sound, just good common sense. The doctor is a man in his mid-80's who appears to have thrived by practicing on himself much of the local medical lore which he tells about and recommends. His book has been a very popular one in the United States, a "best seller" (one of the ten books sold in largest numbers for several months) with sales of hundreds of thousands of copies. However, there is manifest in many places a considerable ignorance of matters chemical. The notion that acetic acid is of therapeutic benefit because of its acidic properties is quite false. Actually it is a weak acid, totally oxidized to carbon dioxide and water in the body soon after ingestion, as are other fruit carboxy acids. The carbon dioxide in the form of carbonic acid plays an important role in buffering the blood; the pH value depends in large part on the ratios of alkaline bicarbonates to carbonic acid. Another unusual viewpoint is the author's opposition to the dietary use of wheat, which has served so long and usefully as the "staff of life" for a large part of the human race. He favors use of rye and corn (maize) cereal grains. (It is true that allergy to wheat is quite common, but this is another story.) His opposition to citrous juices is not based on any scientific facts apparently. Absurd claims are made, thus of the value of honey in treating arthritis (p. 100). He says that bacteria cannot live in the presence of honey because of the presence of potassium (salts) in honey which dehydrate the bacterial cell. The dehydration actually is a factor of the hypertonicity of honey, dependent mostly on the sugars present. The use of mixtures of apple cider vinegar with honey is advocated for many medical conditions, based on its long use among the country people of Vermont. (Is acetic acid in this concentration, used frequently,

not likely to corrode the teeth?). Many other crude products are advocated: the "cappings" (honeycomb), he states, is good for allergy (nasal congestion, post-nasal drip, pollinosis, etc.). The use of comb honey is claimed superior to that of strained honey. Other folk medical agents advocated are kelp, iodine (in the form of Lugol's solution), castor oil, corn oil, and a number of crude plant materials, presented in chapter VII, and representing folk medicinals of the rural areas of Vermont. There is no index.

GMH

"A NATURAL HISTORY OF THE HAWAIIAN ISLANDS" selected readings by E. A. Kay, (Compiler), xii, 653 pp. University Press of Hawaii, Honolulu, Hawaii. 1972.

Includes papers on botanical taxonomy.

GMH

"TAXONOMY OF FUNGI IMPERFECTI"(Proceedings) B. Kendrick, editor, x, 309 pp. University of Toronto Press, Toronto, Ont., Canada. 1971. (rec'd. 1972) $22.50.

This is the text of papers presented and discussions of these at the First International Workshop-Conference on Criteria and Terminology in the Classification of Fungi Imperfecti held at the Environmental Sciences Center of the University of Calgary, Kananaskis, Alberta, Canada. No index.

GMH

"LA PHARMACOPEE SENEGALAISE TRADITIONNELLE: PLANTES MEDICINALES ET TOXIQUES" by J. Kerharo and J. G. Adam, 1012 pp., 44 figs., 24 tabs. Editions Vigot Frères, 23, rue de l'École de Médecine, 75006 Paris, France. 1974. Price ?

This impressive hard-back volume is overflowing with information on the history of the native Senegalese medicine, the drugs in use, ethnopharmacognosy, the individual medicinal and toxic plants, the scientific, common, and vernacular names, remarkable characters of the plants by which they may be recognized, habitats, therapeutic use in the traditional medicine, and the chemistry and pharmacology of those which have been given serious study. Senegal is a black republic in the extreme western part of the African continent with a rich flora and fauna as well as a wealth of ethnobotanical knowledge. Pages 1-105 are devoted to a general consideration of the subject matter, including many references to the literature on African drug materials. The systematic portion extends from pages 106 to 804, in which the families are arranged in alphabetic order, starting with the Acanthaceae and terminating with the Zygophyllaceae. The content is rich with a detailed content of information on about 500 plant species. Many common names and names in various African languages and dialects

are given. The vital pharmacological and clinical properties and considerable chemistry are modern in treatment, and treat not only of the crude plant materials but also and more importantly of the isolated constituents. Thus, the fantastic baobab tree is shown to possess alkaloids, including adansonine, as well as glycosides; a good deal appears now to be known as to the pharmacodynamic effects of the constituents. The third section of the book, pp. 805 to 1011 bears extensive bibliographies and indexes, and represents a very valuable tool in using this work. The literature with 2243 references covers the area up to 1 May 1973. There are indexes of scientific, common, and vernacular names, of active principles, of tables and figures, and a table of contents; also an appendix consisting of the recommendations made at the first "Symposium interafricain sur les Pharmacopées traditionnelles et les plantes médicinales africaines", Dakar, 1968. This is truly a valuable reference work for anyone interested in the potential treasures of natural medicine represented by the tropical vegetation of the earth.

GMH

"MOLECULAR ORBITAL STUDIES IN CHEMICAL PHARMACOLOGY" (A Symposium held at Battelle Seattle Research Center, October 20/22, 1969), edited by L. B. Kier, VII, 290 pp., 67 figs., 66 tabs., Battelle Memorial Institute, Columbus, Ohio, USA. Springer-Verlag, Berlin, Heidelberg, New York. 1970. Soft cover DM 34.40; US $9.40.

For the first time, the molecular orbital theory has been applied to various fields of pharmacology by a group of scientists meeting together to consider this subject of common interest. The past, the present, and the future (as nearly as this can be forecast) are considered as relating to molecular orbital work. Following the Preface, there are 11 papers authored by one to three individuals, each presentation with many references to the literature. The list of 46 attendees includes 10 active participants (those presenting papers), including the chairman. All are listed with their address or connections. Of these, 14 are from Battelle Institute (U.S. and abroad) and two from the Boeing Research Laboratories at Seattle (the Symposium was held in Seattle). These scientists all concerned with the application of chemistry at molecular levels to pharmacology and other biological fields included physical chemists, pharmacologists, theoretical chemical specialists, biochemists, and medicinal chemists. (Americans, Swiss, Germans, and one Frenchman participated.) Electronic structures, quantum mechanics, steric phenomena, and the pharmacologic receptor theory are all treated in these papers. The volume is clearly printed. There is no index.

GMH

"WILD FLOWERS OF THE CAPE PENINSULA" by Mary Maytham Kidd, unpaginated (ca. 150 pp.), 94 pls., 1 map, Oxford University Press, 200 Madison Ave., New York 10016, Edition 2. 1973 (1974). $11.25.

A rather novel mode of arrangement of ca. 814 plant species has been used in this interesting book. This was carried out by using date (month) of flowering as a basis, running in order from January to December. For each month, there has been some further classification by placing together as far as possible plants growing in flats, "vleis", mountain tops, and sand dunes. However, this sub-classification does not seem to be always adhered to. Watercolor paintings have been used as the best medium for accurately portraying the floral and leaf colors and characters, and this has been very well done indeed. Most of the plants shown and very briefly described (if at all) are indigenous to South Africa. To allow it effective and perennial use as a field guide, the covers are stiff card with what appears to be a waterproofed surface. The first edition of 1950 bears a Foreword by the late famous Field-Marshall Smuts, and this has been retained in the present edition. This work should be a highly practical one for pinning down the identity of roughly one-third of the plants of the title area but these are the most important and conspicuous ones of course. Hence the book has greater real value than would be apparent from mere numbers.

GMH

"THE LONG WHITE LINE": the story of Abbott Laboratories by Herman Kogan, x, 310 pp., 56 plates, Random House, 457 Madison Ave., New York 22, N.Y. 1963.

This is the story of an aggressive and radical minded American physician--Dr. Wallace Calvin Abbott (1863-1921)--who pioneered in the field of medical/pharmaceutical preparations. His company, established as The Abbott Alkaloidal Company (1888) has continued up to the present date (since 1914 under the name Abbott Laboratories); and now represents of course one of the major pharmaceutical firms with total annual sales in the neighborhood of 150 million dollars. Some of the products marketed by the company over its approximately 75 years of history include important innovations in therapy--Butyn, Nembutal, Pentothal Sodium, Viosterol, Haliver Oil, and Sucaryl. Abbott has evoked the efforts of scientists of many areas and specialties--men like Volwiler, Roger Adams, Durham, Lanwermeyer, Kamm, Raiziss, Nielsen,--to name only a few. Its business executives also have been outstanding--individuals like De Witt Clough, Vliet, the Stiles brothers (James and David) (who had actually been delivered as babies by Dr. Abbott himself). The story of these men is almost the story of the firm itself, proving again the truth of the saying that history

is the story of individuals. Dr. Abbott started out imbued with the ideals expressed by the Belgian physician, Dr. Adolph Burggraeve, who saw in alkaloids rather than fluidextracts the real essence of medication, where precision and certainty of dosage could be attained. It soon became manifest of course that alkaloids were far from being the sole chemical group with medical benefits, so that at present they represent only a small portion of the total production of the Abbott concern. This book follows a chronological sequence, starting in chapter 1 with the early development of Vermont-born Abbott, and developing there from decade to decade the story of his progress until death overtook him (chapter 6), and from there on the progress of the company under its new heads is developed up to the present time (chapter 17). Error noted: Dr. Beal's father was James not John (p. 93).

GMH

"A GUIDE TO MEDICINAL PLANTS OF APPALACHIA" by Arnold Krochmal, Russel S. Walters, and Richard M. Doughty, U.S.D.A. Forest Service Research Paper NE-138: IV, 296 pp., 2 tabs., 133 figs., 1 col. pl., Northeastern For. Expt. Sta., Upper Darby, Penna. 1969. Gratis.

The first portion of this book is general information on collecting and processing drug materials, and on collecting and drying pollens. There are also references to books and serials, glossaries of botanical and pharmacological terms and of Latin terms used in plant names. Following this is the "Guide to the Plants", in each pair of opposite pages of which a medicinal plant species is described and figured. The figures are more or less equally divided between drawings and photographs, all however with the common quality of usefulness in helping to identify a plant. The 126 different plants are arranged in the order of their scientific names and there is an index of common names following. Many of the photos and apparently all of the drawings are original but there is no list of credits. The following data of value to drug collectors are given under each description: common names, description, flowering period, habitat, harvest (collection), and uses. The plants are those found in Appalachia, the mountainous region of the eastern USA running from the Canadian border or New York State down to central Alabama. Mentha spicata and M. cardiaca (p. 162) are confused. The data on serials might erroneously be interpreted as indicating discontinuance in 1968.

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This volume was also reprinted by the U.S. Department of Agriculture, as Agric. Handbook No. 400: iv + 296 pp., 126 figs., 1971. (Available from the Government Printing Office, Washington, D. C. 20402; $1.75).

GMH

"TABLES FOR ELEMENTAL ANALYSIS" (Rechentafeln zur chemischen Elementaranalyse), by Reinhard Krzikalla, Ed. 2, XXV, 294 pp., many tabs., inserted free 4-page card, Verlag Chemie GmbH, 6940 Weinheim/Bergstr., BRD. 1968. DM. 28,--.

In this edition, all tables have been recalculated on 1961 international atomic weights, where 12C = 12.000 (previously based on 0 = 16.000 as standard). This work is trilingual, as indicated in the title, with instructions in all these languages. (With mostly numerical data, the task is minimal.) By means of this book, one can calculate the proportional combination of the elements of a chemical compound, and hence one is enabled to determine the molecular identity of compounds for which the elementary proportions are known. Besides the tables for the various elements, there are tabular data showing multiples of atomic weights of the metals, a table of functional groups (ex., amido-), table of atomic weights, etc. A table of abbreviations and symbols (ex. Z,) might well have been included. In the English version Introduction (p. XIX), the first sentence of paragraph 2 might better have been written: "Values are generally all tabulated as integral values of molecular weights up to 700; between 700 and 1000 the intervals are increased up to 5 units". The expression "XXIV and" has been interjected into this sentence and rightly belongs in the preceding paragraph, last line, which properly should read: "of the group (see also pp. XXIV and 282-287)." The word "stoichiometry" has been misspelled (pp. XXIII, XXIV).

GMH

"BIBLIOGRAPHY OF VITAMIN E" Vol. VI. 1960-1964 by Wilma F. Kujawski (compiler), unpaginated (about 80 pp.), Distillation Products Industries, Rochester, N.Y. 14603. (Division of Eastman Kodak Company). 1965. (Page size 81/2" x 11").

This volume continues and supplements previous numbers of the series "Annotated Bibliography of Vitamin E" published by the National Vitamin Foundation, and includes 1884 scientific papers. In previous issues, abstracts of the articles were provided, but this has been changed to citation with complete indexing and cross-indexing of each article. There are author and subject indexes. The wide coverage includes occurrence, distribution, determination, chemistry, physiology, pathology, pharmacology, nutrition, metabolism, and diseases and therapy. There are subject and author indices.

GMH

"BACTERIAL PLASMIDS: CONJUGATION, COLICINOGENY, AND TRANSMISSIBLE DRUG-RESISTANCE" by G. G. Meynell. xiii + 164 pp., 27 figs., 8 tabs., MIT Press, Cambridge, Mass. 1973. $14.95.

As accessory chromosomes, plastids play a multiple role inside and outside of the bacterial cell, thus as F or sex factors, as bacterial phases, as colicin (toxic proteins) factors, and most recently discovered as the R factors (which develop resistance to drugs, including the tetracyclines, chloramphenicol, kanamycin, sulfonamides, etc.) The latter function is highly significant in medicinal practice, thus explaining the development of resistant Staphylococci. The plasmids are parallel in functioning to the DNA of some viruses and of mitochondria. A large number of references (672!) is given.

GMH

"EXOTIC PLANTS" by Julia F. Morton. 162 pp., ca. 390 col. figs., Golden Press, New York (Western Publishing Co., Inc., Racine, Wisc.) 1971. $1.95

This is a genuine pocket book and should fit into the pockets of the clothing of men, women, or children, since it measures only 6 inches by 4. The brief but effective descriptions of more than 380 species, each accompanied by a clear and informative color drawing, should permit identification of many a plant encountered by travelers in tropical or sub-tropical areas. It is difficult to see how more information could have been packed into the limited space of six cubic inches! In addition to the major portion devoted to the plants, there are indexes, a glossary, list of plant families, references, etc. The order is the usual Englerian one from monocots to Compositae.

GMH

"REGULATION OF ALDOSTERONE BIOSYNTHESIS" - by J. Müller (Kantonspital, Zürich, Switzerland. - Monographs on Endocrinology Vol. 5: VII + 140 pp., 19 figs., 9 tabs., Springer-Verlag, Berlin, Heidelberg, New York City. 1970. DM 36.- =US $9.90.

This work is published in its entirety in the English language. The usual relationship of one editor to several writers is reversed here with one writer to five editors (Gross, Labhart, Mann, Samuels, Zander). There are 6 chapters, the first three brief, the last three the longest in the volume. The progression of information in the volume begins with consideration of the point of origin in the body of aldosterone - the zona glomerulosa of the adrenal cortex; then proceeds to consideration of the pathway of aldosterone biosynthesis and synthesis of the compound in cell-free systems. Factors governing this synthesis are next considered in considerable detail (angiotension II, cations, ACTH, etc.), then the alterations in biosynthesis and secretion in long-term experiments and in diseases are considered. A summary of conclusions appears at the end, followed by the many references, (there is no

index). It is evident from a study of this text that many factors are influential in controlling secretion of aldosterone, particularly some endocrines. In the past it has often been held that the chief cause of increased aldosterone secretion resulted from the renin-angiotensin system, which results from the production of renin as a pathological product of the kidney (arising from hypertensive processes) and its effect in stimulating production of angiotensin. From this summary of experiments and opinions, it now seems that renin and angiotensin are only indirectly of importance and that other factors actually play a larger part.

GMH

"ORGANISCHE CHEMIE: EIN LEHRBUCH FUER NATURWISSENSCHAFTLER, MEDIZINER UND TECHNIKER" by Friedrich Nerdel u. Bernhard Schrader. Ed. 3 XII + 218 pp., 49 figs., 19 tabs., flexible cloth cover; Walter de Gruyter & Co., Genthiner Str. 13, Berlin 30. 1970. DM. 18,--(ca. $5.00).

Like most revised works (first ed. 1961), this one shows few palpable errors, such as those made by the printer. To indicate the range and utility of the text, the contents may be presented as follows: (1) General discussion of the area of organic chemistry - the various concepts, with emphasis on the electron system for explaining chemical properties; (2) the systematic organic chemistry-aliphatic, aromatic, heterocyclic, and other compounds; (3) macromolecular organic substances; (4) solvents, plasticizers, surfactants; (5) biochemistry; and (6) analytical methods used in organic chemistry. It will thus be seen that this textbook is really an introduction to several areas besides the conventional field of organic chemistry - particularly biochemistry. The work seems to be well done, with excellent clarity, clean-cut figures and formulas, and otherwise attractively presented to the student.

GMH

"MALIGNANT TUMORS IN ORGAN TRANSPLANT RECIPIENTS" by Israel Penn. Recent Results in Cancer Research (RRCR). Vol. 35: IX + 51 pp., 12 figs., 4 tabs. Springer-Verlag, Berlin-Heidelberg-New York. (Editor-in-chief: P. Rentchnick and a group of 50 editors). 1970. DM 24,--, US $6.60.

The largest part of this book deals with case reports (found on 25 pages out of 40 pages of text). The study is based on malignancy and immunologic deficiency states occurring both in experimental animals and in man, then with malignancies in recipients of organ homografts (grafts obtained from another specimen of the same anumal species), malignancies (1) present before or at time of transplantation, (2) transmitted with the transplant, or (3) arising in the tissues some time after transplantation. The author is a professor and surgeon of Denver, Colorado. Besides his own studies, there is an extensive bibliography of 186 titles plus a mixed index. The present interest in cancer is reflected in the broad

spectrum of nationalities represented on the board of editors: 14 Americans, 7 Frenchmen, 6 Swiss, two each of Russians, Englishmen, Japanese, Italians, and Israelites, and one each of Canadians, Belgians, Finns, Swedes, Danes, Dutch, Norwegians, and Poles, the figures including the editor-in-chief.

GMH

"ARBOLES TROPICALES DE MEXICO" by T. D. Pennington and José Sarukhan. vii + 413 pp., 279 drawings, 159 photos, Instituto Nacional de Investigaciones Forestales, Mexico 21, D. F., Mexico and FAO, United Nations, Rome, Italy. 1968. (US) $6.00.

This "Manual for the identification in the field of the principal tropical trees of Mexico" is a very useful guide for both botanist and non-botanist. For the latter there is introductory information defining botanical terms (with illustrative figures) and a text that is not overly technical. The introductory material also includes information on the types of arboreal vegetation found in the hot-humid zone of Mexico and keys to the species which are taken up in the main body of the work. In the species description section, each plant is assigned a double spread of two pages, the left one with text, the right with a figure of foliage and reproductive organs together with a distribution map for Mexico. Important information conveyed by the text include after the scientific names (including family and sometimes sub-family) vernacular names, the general nature of the plant (form), bark, wood, branches, leaves, flowers, fruits (including seeds), the ecology and distribution, and uses. On the same page there is regularly reproduced a photograph of the stem (trunk) of the tree. At the end of this tome is a bibliography, list of herbarium specimens studied, and a comprehensive index.

GMH

"A BEACHCOMBER'S BOTANY: AN ILLUSTRATED HANDBOOK OF NEW ENGLAND SHORE PLANTS AND SEAWEEDS" by Loren C. Petry† and Marcia G. Norman. 158 pp., ca 130 figs., Chatham Press, Old Greenwich, Connecticut. 1968. $6.95.

A book like this one has both a scientific educational value and an aesthetic value for the pleasure transmitted through the excellent charcoal drawings with which the pages are embellished. The artist (MGN) has not only given us an image of the plant which actually is very real and effective but also has inscribed on the same page with the drawing a brief description following the common and scientific names. This book would educate quite painlessly in the recognition of the principal plants of the sea coastal areas of New England. Preceding the section of plants (the "systematic" portion), the late Professor Petry has talked in some detail (37 pages) about the environment concerned and the nature of the plants found there. This section was written for the layman, apparently, since there is one

chapter on the naming of plants. The title is not quite accurate since seaweeds (Algae) are plants. However the layman as a rule thinks of plants in terms of flowering herbs and shrubs, so that this should not be considered anything more than a popularization of title. The area of the beach covered includes the tide line, the dunes, and the land bordering the dunes, as well as salt marshes.

GMH

"PROGRESS IN THE CHEMISTRY OF ORGANIC NATURAL PRODUCTS" (FORTSCHRITTE DER CHEMIE ORGANISCHER NATURSTOFFE), vol. 29 by W. Herz, H. Grisebach, and G. W. Kirby (Editors). VIII + 554 pp., 18 figs., Springer-Verlag, Vienna. 1971. $57.40.

For over a third of a century (34 years), or if you like for over a generation (33-1/3 years), this series of volumes has been accepted as an excellent source of review articles covering important topics of the time in the field of plant and animal substances. Volume 29 is a larger and more impressive volume than most of its predecessors and is printed throughout in a smooth-finished heavier paper of the type used for printing half-tones. Of the eight articles, three are in German, five English. The nine authors are natives of the USA, England, Germany, and Israel. As usual, considerable variety prevails in the subject matters. Thus, the first article deals with piperidine compounds found in nature, including among these importantly the alkaloids, the betalains, and some antibiotic substances. Several of the alkaloids are well known, - thus lobeline, coniine, the Punica group, febrifugine, and others. (The closely related pyridine alkaloids are not taken up). Article 2 deals with bile pigments and "biliproteids" (or biliproteins) which latter are found in the Algae. A new word "bilins" is introduced, the equivalent of "bile pigments" (German, Gallenfarbstoffe). This article is concerned exclusively with the chemistry and occurrence of these compounds. The third article, also chemical, deals with the glutarimide antibiotics, a group which has no well-known commercially available representatives. They are derived from Streptomyces spp., the first discovered being Actidione (now cycloheximide). The next article concerns itself with the chemistry and biosynthesis of lichen substances; these substances have proven of considerable utility in determining botanical relationships, in other words for chemotaxonomic uses. Another contribution deals with the cucurbitanes, representing tetracyclic triterpenes, with as the most important derivatives, the cucurbitacins. The latter have many interesting properties of medical import - acting as purgatives, cytotoxic agents, anti-tumor agents, and even as insect attractants (for some species). Follows a chapter on biogenetic-type synthesis of terpenoid systems, and one on the biosynthesis of the diterpenes, including the gibberellins. The last paper is one of the most interesting, dealing with the chemistry of natural products from marine sources, involving scores of compounds, some of which would seem to have high priorities in the research and development program, for instance, kainic and domoic acids, anthelmintics from Digenea simplex.

Needless to say, the book is a must for many private and public libraries.

GMH

"ACETABULARIA AND CELL BIOLOGY" by S. Puiseux-Dao. XII + 162 pp., 45 figs., 13 pls., Springer-Verlag New York, Inc., 175 Fifth Ave., New York 10010; and Logos Press Ltd., London. 1970. Cloth. US $9.80.

The author of this book is renowned for her knowledge and experience with the giant unicellular organism, the chlorophyceous Alga, the various forms of which are collected under the generic name Acetabularia. She has written concisely but interestingly of her own experiments with the organisms together with a capable review of the world literature. This book is different from the majority of books which recapitulate the published literature of many experimental studies, since here is primarily an incorporation of the experimental researches of the author herself, much of which has not previously been published. The organism grows in tropical marine waters. (The reviewer's attention to this group was first directed by his finding on the beach at Panama City, Florida, of a dried calcified specimen with its characteristic mushroom-like cap, growing attached to shells). Throughout the book, mention is continually being made of the species A. mediterranea, whereas a foot-note on page 1 indicates that the accepted name for this entity is now A. acetabulum. No doubt the new information or interpretation came too late to make the necessary changes in name throughout the volume. In the tabulation on page 35, mention is made of 19 species known, divided into two sub-groups, Acetabularia s.s. and Acetabularia popyphysa, with 11 and 8 species respectively. Seven species have been used in various experimental laboratories. In addition to the initial chapter on the biology of the group, there are special chapters on morphological structure and ultrastructure, reproduction, life history, culture, merotomy (cutting the plant body into nucleate and non-nucleate parts), grafting, biochemistry, protein synthesis, etc.

The chloroplasts are considered together with their functional periodicity having to do with phases of synthetic activity. The interest in this organism lies apparently in the possibilities of learning from it more about the secrets of cell life. The text is clear and accurate. A bibliography and index are included at the end.

GMH

"BIOLOGY OF PLANTS" by Peter H. Raven and Helena Curtis. XII + 706 pp., 633 figs., 21 tabs., Worth Publishers, Inc., 70-5th Ave., New York 10011. 1971 (1970). $12.95.

It has sometimes been said "Don't judge a book by its cover." So far as concerns the title under review, it can be said that the title on the cover is short and to the point and adequate and as for the physical nature of the cover, this tome is strong and attractive

and to all purposes most adequate. A study of the contents will show to any fair-minded and unbiassed individual that we have here what must approach the ideal in a textbook on the subject. The introduction presents a picture of life in general--how it may have originated, the outlines of evolutionary change, the relationships of organisms to one another and to the environment. The first section considers the cell--its chemical composition, structure, "energetics" (= conversion of energy), and mechanisms of inheritance. Section two is devoted to the development of the individual plant: its life history (biography), integration of growth processes through plant hormones, and the effect of external conditions on its growth. In the next section, the central and pivotal processes of photosynthesis and respiration are considered. Section IV takes up the relationships of the plant to soil and water. In Section V, genetics and evolution are given a pretty thorough review, with emphasis on diversification of plants, leading up to the taxonomic treatment of Section VI, concerned with the classification of plants. In this text, five kingdoms of living organisms are recognized: the Monera (procaryotes; all of the other four being eucaryotes); the Protista; the Animalia; the Fungi; and the Plantae. (In this treatment, Plantae include the multicellular Algae, Bryophyta, and all vascular plants). Section VII is devoted to ecology and the last section is headed "Man and the World Ecosystem." There are four appendices, a glossary, and a detailed index. Truly this is a splendid book for the student of botany!

GMH

"CHEMISTRY AND BIOLOGICAL ACTIONS OF 4-NITROQUINOLINE 1-OXIDE" P. Rentchnick, Editor in chief. Recent Results in Cancer Research (RRCR) vol. 34. XII, 101 pages, 20 tabs., 12 figs., Edited by H. Endo, Kyushu University, Fukuoka (Japan), T. Ono T. Sugimura, both National Cancer Center, Tokyo. Springer-Verlag, Berlin-Heidelberg-New York. 1971. Cloth DM 36,--; US $9.90. (A discount of 20% on list price is granted to those purchasing the complete series.)

A large literature has grown up around the class of carcinogens represented by as chief member 4-nitroquinoline 1-oxide. An attempt has been made, a successful attempt, to review these many papers in a single handy volume. Most of the review chapters in the present volume were supplied by staff members of the National Cancer Center Research Institute (NCCRI) at Tokyo, Japan. Also represented are the Cancer Research Institute at Kyushu University (Fukuoka), the Japanese Foundation for Cancer Research, and the Research School of Biological Sciences of the Australian National University (Canberra). (Actually all authors were at one time or other associated with NCCRI.) The carcinogenicity

of the title compound was proven in 1957 by Dr. Waro Nakahara of the NCCRI, Tokyo, after synthesis of the compound in 1942 by a Japanese group. The early work showed development of squamous cell carcinoma in mice skin after the compound in solution was painted on the skin. Following the brief introductory chapter, there are chapters on the chemical properties, biophysics, carcinogenicity, metabolism, molecular aspects of action, anti-tumor effect (because strangely enough the compound in addition to its mutagenic effect also has a strong carcinostatic activity), and microbiology. The last chapter details the mutagenic effects on bacteria (the initial studies on the compound were in this area), fungi, yeasts, and protozoa. The reference section (with about 300 literature references) and a subject index complement the text.

GMH

"CURRENT CONCEPTS IN THE MANAGEMENT OF LYMPHOMA AND LEUKEMIA" Editor in Chief: P. Rentchnick. Recent Results in Cancer Research (RRCR) vol. 36. XIV, 198 pages, 46 figs., Edited by J. E. Ultmann, M. L. Griem, W. H. Kirsten, and R. W. Wissler. Springer-Verlag, Berlin-Heidelberg-New York. 1971. Cloth DM 48,--; US $13.90. (A discount of 20% on list price is granted to those purchasing the complete series.)

This text represents the proceedings of a symposium on cancer, specifically lymphoma and leukemia, held at the University of Chicago Medical school in March, 1970. There were 24 invited speakers, but 27 are listed as "contributors" With the exception of one Englishman and two Canadians, the speakers or participants are all from the United States. Other statistics: the general editorial board of this series of books has 51 members, this particular volume has four editors, of whom three are also authors of articles. The last decade has undergone great advances in the diagnosis and treatment of these diseases. Much of the advance has been in determining just how curable a particular case may be and to determine at which stage the disease process stands (this is called "staging"), and what particular type of therapy is best applied. More precise differentiation of tumor types is now possible and more efficient application of radiotherapy (in lymphomas) and intensive chemotherapy (in acute leukemia). Advances in the management of the patients with chrominic leukemia and incurable cases of lymphoma are also reported here. Out of the 20 chapters and discussion sections found in the text proper, three deal with the pathology (microstudy of sections), two with evaluation and "staging", four with radiation therapy, six with chemotherapy, two with immunological reactivity to the tumor antigens, and one each to general therapy for acute leukemia and Burkitt's tumor (malignancy of lymphoreticular system, first reported 1959 from Africa). The text has five major divisions: diagnosis of lymphoma,

radiotherapy of lymphoma, therapy of acute leukemia, chemotherapy of chronic leukemias and lymphoma, and "new approaches" to management of leukemia and lymphoma. These include 14 formal lectures, together with eight sometimes rather elaborate "discussions" and introduction and summary units. There is no index. What is it that someone has said? "Every book should have an index", even though not in full detail. Mention is made at several points of Hodgkin's disease. Although this disease is often classed as a lymphoma of chronic type, there is still much controversy as to its specific nature. It is generally regarded as a malignant neoplasm; however, there is some evidence now that it starts out as a benign neoplasm; it is known often to be curable. The importance of these malignant diseases may be gauged from the fact that in 1969 by one research agency alone in the United States, the National Cancer Institute, expenditures of $40-50 million were made on leukemia and lymphoma.

GMH

"CHECKLIST OF THE GRASSES OF NEW YORK STATE" by S. J. Smith, iv, 44 pp., 2 tabs., 1 map, N. Y. Sta. Museum & Sci. Serv. Bull. No. 403. 1965 (Oct.).

This listing of 366 recorded species and major races shows the distribution in 26 divisions of the state, together with rejiciendae, hybridae, minor variants, references for descriptions, and bibliography. A synonym listing is added, also blank tabular pages for further entries by interested persons.

GMH

"CONCEPTUAL MODELS OF NEURAL ORGANIZATION", by John Szentagothai and Michael A. Arbib, ix, 205 pp., 63 figs., The MIT Press, Cambridge, Mass. 02142. 1974. $8.95.

Attempts to synthesize from the ever accumulating mass of neurological data a pattern which would give order and rational organization to studies of brain structure-function relationship have been revealing only of the fact that a single hierarchic principle provides a very inadequate matrix. Accepting that no monolithic or simplistic reduction of data is possible and recognizing the need for organizational principles on which to base hypotheses, the authors have extracted from the presentations and discussions of the Neurosciences Research Program work sessions evidence of manifestation of basic principles of neural organization. The first three chapters develop the evidence for a set of

criterion-satisfying principles of neural organization. Theories relate bio-systems to electronic servo system counterparts by fascinating use of examples, many directly from the work sessions. Drawings, diagrammatic or semi-diagrammatic, effectively support the narrated ideas. The use of evidence as to effects of artificially altered development to support theories of engineering of neural connectivity serves as an example for the concern of the authors with plausibility. The last two chapters look at the applicability of the organizational principles in the workings of systems which are basic in biological neural-dependent adaptation. Chapter IV deals with stereopsis and Chapter V with the cerebellar modulation of voluntary motor function. The book's contribution is in its unique use of the valuable contributions of the work session participants, not limiting itself to a reporting of contributions and individual concepts or opinions as to organization, but presenting instead a very imaginative yet plausible concept of the framework of neural architectural engineering.

Byron B. Williams, Professor
(Auburn University, Auburn, Ala.)

"LICHENS OF OHIO. PART 2. FRUTICOSE AND CLADONIFORM LICHENS" by C. J. Taylor, v. + pp. 153-227, A-1 to A-22, plus 10 pp., 146 figs., 60 maps, Ohio Biological Survey, Biol. Notes No. 4 (Ohio State Univ., Columbus). 1968. $3.00.

(For review of Part 1, see Phytologia 27: 180; 1973).

In this treatment of the shrub-like (frutex, L., shrub) and squamulose (scaly) lichens, much the same plan has been followed as in Part 1, with an entire page devoted to each species, complete with photographs, description, diagnostic characters, constituents, chemical identifying tests, and county distribution (with marked Ohio map). 62 species are so covered belonging to ten genera, chiefly Cladonia (with 38 species). There are several keys. An additional feature is the valuable appendix, with data on the various lichen acids (27) including photo-micrographs of crystals. A pictured glossary (photographs to illustrate the textual descriptions) and a 2-page bibliography to supplement the more extensive one of the first part, conclude this useful volume. Part III will be published in 1970-1 and will include the crustose lichens. In this work in three parts, we find an unusual graphic and detailed presentation on the lichens of one State, which is however of universal interest because of the wide geographical distribution of so many of the Lichens.

GMH

"INTRODUCTORY BOTANY" by Arthur Cronquist, Ed. 2, ix + 886 pp., many figs. Harper & Row Publishers, 49 E. 33d St., New York 10016. 1971. $14.95(US).

This large and sturdy text-book is aimed at undergraduate students of botany in the tertiary schools (colleges and universities) of the USA. Although dubbed "introductory" it would be useful in nearly all courses of botany taught to undergraduate students, inasmuch as there is coverage of such a wide array of fields as the following: taxonomy, morphology, histology, cytology, physiology, genetics and heredity, evolution, plant sociology, ecology, biogeography, economic botany, and even some degree of biography (with portraits of eminent plant scholars and brief notes about them). There is not very much information, however, on phyto- or biochemistry, so that in this area another book would be necessary. The first edition published just a decade before was an excellent book, but the new edition shows many improvements, including greater use of electron microphotographs, changed concepts in the evolution of plant groups, the reclassification of the monocotyledon and dicotyledon sub-classes, changes in nomenclature, and so forth. This book should be an effective text.

GMH

"LE PIANTE MEDICINALI NELLA CURA DELLE MALATTIE UMANE" (Medicinal plants in the cure of human diseases) Ed. 2, by Dr. L. P. Da Legnano, 984 pp., 16 col. pls., many line drawing figs. Edizioni Mediterranee, 158 Via Flaminia, Roma, Italia. 1968. L. 10,000.

The subject matter is divided into a general part and a special part, followed by a bibliography, glossaries of botany and medical, pharmacological, and therapeutic terms, an index of the special section on the chief plant drugs (see below), an index of the secondary indigenous and exotic drug plants not included in the section just mentioned, and an analytical index to the entire volume exclusive of bibliography, glossaries, and listing of secondary drug plants. (It would seem logical to include the latter listing in the general index). In the general part, many facets related to medicinal plants are discussed, including history of use, modern medicine and phytotherapy, value of some of these substances as dietary articles, production of medicinal plants and plant drugs and human health and hygienic practices. In the special part, the various diseases are taken up systematically, in the following order; head, face, locomotive apparatus (skeleton, joints, muscles, limbs), nervous system, integument, digestive organs, respiratory system, circulation, genito-urinary apparatus, and mixcellaneous (infection, parasitic infestations, trauma, poisoning or intoxication, emergency assistance, accidents, professional diseases, zoönoses, gerontology). In this, the chief part of

the volume, the various diseases or disorders are defined, then the drugs are listed in alphabetic order which are recommended for use in relief or cure; preparations and doses are indicated. At the end of this section, a special section on "chief plants", covering 238 pages, takes up the various drugs referred to in the previous text, with one drug taken up on each page as a rule (hence about 235 drugs) and each generally with a drawing of the plant and its parts. These are arranged in the alphabetic order of their Italian names, starting with Abete bianco (Abies alba). The plant is described, with habitat, the part or parts used discussed, and the special uses made, also other "varied" information. The various drugs referred to in the special part preceding this are not indexed in the terminal index. This would appear to be one of the most complete treatments of herbal medicine.

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"TREATMENT OF MALIGNANT BREAST TUMORS—Indications and Results: A Study Based on 1174 Cases Treated at the Institut Gustave-Roussy between 1954 and 1962", by P. Denoix (Institut Gustave-Roussy, Villejuif (France)). Translated into English by B. Crook. Recent Results in Cancer Research, Editor in chief: P. Rentchnick. (RRCR) Vol. 31, X + 92 pp., 18 figs., 41 tabs. Berlin-Heidelberg-New York: Springer-Verlag (H). 1970. DM 48,22; US $13.20.

The Gustave-Roussy Institute at Villejuif, France, is well known in the area of treatment of malignancies. In this volume, its recent record in the diagnosis and treatment of malignant breast tumors is thoroughly reviewed. In Part I, the various bases on which appropriate therapy is established are reviewed. Included here are the phase of development of growth, lymph node status, the possibility of spread through metastases, delineation of location and dimensions of growth of the tumor, possible extent of surgical intervention, radiotherapy before and after operation, endocrine therapy, direct surgical and radiant procedures on the endocrine glands, chemotherapy, and immunotherapy. Part II expounds the application of team work--cooperative efforts of a so-called "Localization Committee" made up of physician, surgeon, and radiologist. The treatment protocol discussed in part III is an effort made at total management by the Committee by the use of correct classification for a better understanding of what can be done in mastering the disease process in the individual case. For this purpose, the TNM classification (of the International Union Against Cancer) is utilized: the letters stand for primary tumor extension (T), clinical appearance of adenopathy (N), and metastases existence or absence (M). The degrees within each letter category are shown in gradation of severity (0,1,2,...). Appropriate therapeutic (medical, surgical, radiation) measures are carefully plotted following a program found successful in

previous similar cases. Part IV reviews the results obtained over a 9 year period in which this strategy has been applied. Out of a total of 1174 cases seen 1954-62, the protocol was followed in 916 with a 5-year survival rate of 46%. An appendix furnishes tables showing the survival rates as related to treatment schedules. The book reflects another advance in the control of a very serious disease.

GMH

"DICCIONARIO MEDICOBIOLOGICO UNIVERSITY". Con vocabulario Ingles-Español y Español-Ingles, xxxv, 1503 pp., several figs. and tabs. Editorial Interamericana, S.A., Cedro 512, Mexico 4, D.F., Mexico. 1966.

In spite of the title of this volume, the overwhelming bulk of text is devoted to the English-Spanish portion (pp.1-1266), the Spanish-English part constituting only in pages less than 1.3% (pp. xix-xxxiv). The last section of the dictionary (238 pp.) is occupied with special information, such as difficulties in translation of English into Spanish, laboratory normal values, functional tests, examination of injured patients, medical emergencies, the periodic table, thermometric and metric equivalents, log tables, weight and height tables, immunization data, detailed information on medicaments, with indications and dosage, with listings of drugs under various therapeutic classes (pp. 1315-1378), and finally tables of arteries, bones, ligaments, muscles, nerves, and veins. All of this is in Spanish, with the exception of some English equivalent names and the Latin, where applicable.

The University Medicobiological Dictionary should have a wide interest during this period of rapid development of the Latin-American nations, since it covers the following fields of serious interest: biology, biochemistry, human medicine, veterinary medicine, dentistry, and the infirmary (hospital).

A preliminary section preceding the dictionary text proper includes rules for using the dictionary, abbreviations, and the Greek alphabet (pp. xiii-xviii).

Considering the 2-column page and the fine type, there is really an enormous volume of information contained in the work. The definitions are much more than merely equivalent words, but give a concise and sometimes detailed definition. The work was of course intended for Spanish-speaking people who are often obliged to read books or journal articles in the English language. The terms defined cover a wide range of subjects: included are anatomical terms, medical words, such as for diseases, medicinal compounds, personal names (ex. Walter Reed), common names (disease, etc.), technics, and abbreviations.

GMH

"DIE KRANKHEIT - DEIN FREUND; DIE REVOLUTION DER BIOLOGISCHEN HEILWESEN" by Dr. med. Rolf Trumpp, 104 pp., 5 figs., Karl F. Haug Verlag, Ulm/Donau. 1961. DM 6.80.

The author has endeavored to approach the treatment of the diseases and disorders of the human body from a different angle than the conventional one involving injections, tablets, irradiations, immunizations, etc. He calls this new mode of treatment, which spurns all of the complex equipment and medicines of most physicians, the "biological" concept of healing, and proposes that infections, inflammations, allergies, skin and mucous membrane disorders, obesity, hypertension, liver and gall bladder disorders, pain, and so on, can often be effectively countered by such means as dietary control, exercises of all sorts, and better habits of living. Even for cancer, the doctor proposes a "biological" control, although, since he regards this as a terminal state of ill health, he admits that not much can be done in the way of positive treatment by his system. He represents cancer as the ultimate degeneration of the organism due to a long series of errors in diet and living modes; the therapy here is a genuinely prophylactic one, extending over many years if not effectively the life span. The two pages of bibliography are interestingin showing how active the interest now is in Germany in a "natural" or "organic" or "biological" program of health, with major emphasis on the nutritional angle; here are listed 9 journals and 24 books published in recent years by such publishers as H. G. Müller, Hippokrates, Paracelsus, E. Schwabe, Haug, and others.

GMH

"EXPERIMENTAL PHARMACOGNOSY" by V. E. Tyler, Jr. (formerly at Univ. Washington, Seattle) and A. E. Schwarting (University of Connecticut, Storrs, CT), v + 105 pp., Ed. 3. 1962.

This series of 31 exercises for undergraduate pharmacognosy laboratory work evidences the modern and inevitable trend of the subject matter. While macroscopic and microscopic studies are included as an important part of the procedures to be studied, there are also presented biochemic techniques for isolation of active principles and even for several elementary biosyntheses. Pollen examination, chromatography (both column and paper), fluorescence analysis, and chromogenic analysis (application of color tests) find a place in this manual. An added feature is a key for the identification of powdered drugs. The book has been thoroughly revised by deletion of some portions of edition 2 and insertion of others, leaving the time coverage in laboratory periods about the same.

GMH

"ANDROGENS II AND ANTIANDROGENS" (Androgene II und Antiandrogene) by various authors, X + 628 pp., 179 figs., 164 tabs., Springer-Verlag Berlin, Heidelberg, New York. 1974.

A little more than one-third of this text concerns the androgens or male hormones; all the balance is taken up with a detailed discussion of the anti-androgens. The portion on androgens continues and concludes a discussion on androgen receptors in cells of target organs which was initiated in the first volume. A great deal of biochemistry is included in this discussion. The next three chapters deal with the detection and chemical determination and biological evaluation of the androgens. A final chapter in this section on androgens details the clinical uses, of which there are a great many. The following detailed discussion of the anti-androgens is said to be the most complete survey available. The first article or chapter reviews in detail the chemistry, physiological activity, and the medicinal applications of anti-androgens, which include such compounds as cyproterone and its acetate benorterone (17 α-methyl-β-nortestosterone). In a second chapter, the various effects on the sexual organs, puberty, sterility, libido, aggressive psyche, and sexual differentiation are discussed in depth. It is shown that the anti-androgens also have influences on other body organs, such as the thyroid, liver, blood manufacture in bone marrow, etc. These are taken up by the author in considerable detail. The special applications or potential applications of the anti-androgens on hypersexuality and sexual perversion are also considered in a third chapter. It is surprising how many practical applications there are in the use of these medicinal agents. For example, the sex odor of boars is so unpleasant that the meat of these animals is unsuitable for human consumption. Ordinarily, the animals are castrated well before butchering. The oral administration of a potent anti-androgen to the uncastrated animals permitted marketing of a carcass completely free of the sex odor. With the exception of chapters 3 and 4 (127 pages), all of this volume is in English. All eleven of the authors live in Germany, four being employees of Schering AG., two members of the Max Planck Institute. This most excellent work with its companion volume should be on the shelf of any library concerned with physiology, biochemistry, pharmacology, or medicine and on the desk of the physician and endocrinologist.

GMH

"TREES, SHRUBS, AND VINES" by Arthur T. Viertel, unpaginated (ca. 250 pp.), 596 figs., Edition 3, Syracuse University Press, Syracuse, New York 13210. 1970. $4.95 paperbound.

With this convenient spiral bound guide, one should be able to identify with minimum difficulty the important ornamental

woody plants of the northern United States (north of Washington, D.C.) and southern Canada, that is with the exception of conifers. Roughly half of the pages are devoted to illustrations, chiefly of leaves. 593 species are included. There is only one brief key (about half a page) to leaf forms and sizes. The descriptions are adequate and relate to all parts of the plant. Since the identifications are based chiefly on vegetative characters, the naming of plants should be both easier with this book and also possible over a longer time period.

GMH

"TEXTBOOK OF ORGANIC MEDICINAL AND PHARMACEUTICAL CHEMISTRY" by C. O. Wilson, O. Gisvold, and R. F. Doerge, Sixth Edition, xix + 1053 pp., 31 figs., 106 tabs., J. B. Lippincott Co., Philadelphia, Pa. 1971. $24.00.

This is the best known of the American texts on the subject appearing in the title of the book. (A review of ed. 5 appeared in Acta Phytotherapeutica 18: 15-16; 1971). The latest edition has a "sharp" appearance--bound in red cloth--and the contents show again considerable improvements over earlier editions. The same authors and the same editors prepared the text. This book is to be recommended for any student of the chemistry of medication, whether natural or synthetic.

GMH

"EVALUATION AND TESTING OF DRUGS FOR MUTAGENICITY: PRINCIPLES AND PROBLEMS"--Report of a WHO Scientific Group. World Health Organization Technical Report Series, No. 482, 18 pages. Also published in French; Russian and Spanish editions in preparation. Available through H. M. Stationery Office, P.O. Box 569, London SEI 9NH (and elsewhere). 1971. Price: 20p, $0.60, Sw.fr. 2.--.

As a result of this meeting, several findings and recommendations are presented: (1) All drugs ought to be evaluated for possible mutagenicity; (2) guidelines are needed to determine priorities; (3) a test program is suggested; (4) additional tests are promising and research to this end is proposed; (5) in mutagenic testing, both genetic and pharmacological objectives are needed; (6) coordination of test procedures and appropriate data recording and information services are required; (7) fundamental and applied scientific research is a top priority; and (8) an interdisciplinary approach by geneticists and pharmacologists is advised.

GMH

"HERBARIUM OF CHRISTIAN STEVEN" by I. Kukkonen and K. Viljamaa, iii + 113 pp., 1 portr., 4 figs., Helsingin Yliopiston Kasvimuseon Monisteita 4 (Univ. Helsinki, Bot. Museum, Pamphlet No. 4.) 1971 (rec'd. 1973).

The herbarium of Steven (1781-1863) was bequeathed to the University of Helsinki in 1860. A biography, list of publications, list of geographic names referred to in herbarium labels, dates and localities of Steven's own collections, names of collectors and origin of specimens obtained in exchange by Steven, a bibliography, and specimens of Steven's handwriting are included in this spirally-bound book.

GMH

"INTRODUCTION TO THE FINE STRUCTURE OF PLANT CELLS" by M. C. Ledbetter and K. R. Porter, IX + 188 pp., 51 pls., 7 text figs., Springer-Verlag, Berlin--Heidelberg--New York. 1970. DM 54,--; US $14.80.

In this volume, the great values of the electron microscope are revealed in showing the intimate details of structure of many plant parts. The book is printed on folio sheets of heavy smooth paper ideal for the reproduction of the microphotographs. Interspersed with the plates are descriptive texts in which all of the structures shown on the plates and marked with abbreviations are explained and related. The contents are distributed in ten chapters having the following subject matters: general cell structure; fine structure interphase (or resting) cell and cell organelles; dividing cells; cell wall and plasmodesmata; vascular tissues (vessels and sieve tubes with companion cells); sclerenchyma (mis-spelled schlerenchyma) (fibers and stone cells) and collenchyma; epiderma cells and variants; photosynthetic apparatus (mesophyll, chloroplasts); cells having special inclusions (chromoplasts, laticifers, tannin cells); germinative tissues (PMC, pollen grains, pollen tubes, etc.). A valuable feature of the book is the "Supplementary reading" which follows the descriptive texts for the plates, these references mostly in English and German will enable further study of the particular topic; often such references are hard to locate. Some of the plates represent magnifications in the light microscope range; these are intended for orientation purposes and are usually followed by more detailed electron microscope photographs showing a small part of the field in much greater detail. The 51 plates contain by actual count 64 figures, of which seven are diagrammatic sketches and not photographs. The volume has a multitude of uses and applications: it will interest students in biology and botany at the lower levels by furnishing concrete examples of some of the cell micro-devices which enable it to function. It will be most useful to advanced students by furnishing excellent representations of the important furniture

of the cell. To a plant histologist the illustrations will broaden and sharpen his understanding of many structures of the cell about which his knowledge is limited by the limited capability of the light microscope. This album should of course be a part of every adequate college and university science library.

GMH

"36 LECTURES IN BIOLOGY" by S. E. Luria, xix + 439 pp., figs. and tabs. (s.n.), The MIT Press, Cambridge, Mass. 1975. $8.95.

In this large paper-bound volume printed from typewritten script and embellished with many sketches, we are presented with the lecture notes of a course in general biology taught at Massachusetts Institute of Technology in the springs of 1973 and 1974. Salvador E. Luria, the author, is a Professor of Biology at MIT and a Nobel Prize winner. These lectures fall into five groups, starting out with cell biology and cell chemistry (4 lectures), biochemistry (9 lectures), genetics (8 lectures), developmental biology (7 lectures), and physiology (9 lectures). Students (it is said) were not obliged to take chemistry previous to this course, since sufficient organic and physical chemistry was included in the lectures and in "background material" appended to the text for this purpose. From looking over the text, one is led to conclude that the lectures must have been interesting because of the lucidity of the phraseology and because of the numerous illustrations used, sometimes giving the semblance of a "chalk talk", so popular many years ago. For each two or three lectures, there is presented in the back of the book a section of "Review materials", representing topics for discussion often as problems or deep probing questions, perhaps something of the order of an open book examination. Following these is a section of examination questions, these representing rather broad queries covering much of the content of the book and apparently intended for students after the completion of the text. The index is not detailed but apparently adequate. This book represents really a kind of challenge to undergraduate students in biology and its branches.

GMH

"WIZARD OF TUSKEGEE" by David Manber, 163 pp., 21 figs. (photos), The Macmillan Company, New York; Collier-Macmillan Canada Ltd., Toronto, Ontario. September, 1967. No price given.

The text of Wizard of Tuskegee is well suited for the junior high school age group, yet the content and undisputed genius of the character lift the book to a wide range of readers. The budding chemist or botanist will find it

stimulating. From the time of the alchemists' efforts to turn base metal into gold to the Space Age spans many years, yet one feels that George Washington Carver contributed a giant step in man's accomplishments through the use of simply derived products. It would seem that any reader, whatever his interest, would feel the fantastic creativity of Dr. Carver. His innate compassion for living things, his oneness with Nature, seem almost to tap the secrets of Creation itself. Even the students of "mind stuff" will find his "visions" interesting. Those who are looking for racist issues might be disappointed. Even though Carver's circumstances were unique i.e.-being reared by whites, allowed an education - the obstacles were formidable. Or they might take issue with the fact that he concerned himself with advocating trade schools instead of the professions. But he was concerned with the survival of his race and their self-improvement. And the time was the 19th Century, when it was almost impossible for a Negro to succeed in anything. The theory that once in a while a man is born at an opportune time for optimum achievement seems proven in Dr. Carver's life. One feels that even though society narrowed his choice to agriculture teaching and private research, it would have been the world's loss had he chosen otherwise. The book is well written and the author's style of understating adds to its strength.

Mrs. Jet Gainer, Decatur, Ga.

"PIONEER COMFORTS AND KITCHEN REMEDIES" by Ferne Shelton, ("Old time highland secrets from the Blue Ridge and Great Smoky Mountains"). 25 pp., Hutcraft, High Point, North Carolina. 1965.

Much native practice from the Appalachian Mountains area is recorded here, all the way from foods, beverages, and spices to dyestuffs to insecticides to medicinal plant materials; there are even some "charms", such as those involving asafetida, buckeyes, and Samson Snake Root.

GMH

"DICTIONARY OF FOODS AND COOKERY TERMS" by C. Herman Senn and Harold C. Clarke, v + 164 pp., Ward Lock Ltd., Pretoria Road, London. 1973. £ 2.25.

This is a compact little book filled with many answers to questions all of us sometimes ask. Included in the content of the Dictionary are many foreign words, particularly French, obviously a result of the preeminence of the Frenchman in the area of the cuisine. Words defined include principally foods but also beverages, drinks (ex. water), condiments, recipes, menus, and numerous terms used in cooking. Some words are indicated as being French (F) which actually are not such or at least are words commonly used in the English language; thus, agaric, ananas, aspic, aril, marmalade, and others.

Poppy seeds do not contain a small quantity of opium as stated (p. 116); coca and Kola are confused; coca is not the nut of Erythroxylon coca (p. 43); the definition of Mint is too general; peppermint has been known only for about three centuries. Omissions: peppermint; spearmint; acerola; Cola; Kola; pasta; paste; ramps; rampion (Campanula); girasol (Jerusalem artichoke); Akavit, espresso, Drambuie, mescal; Bloody Mary; schnapps; Martini; Manhattan; hamburger; frankfurter; Coney Island; pistachio; peanuts; sunflower seeds; pigweed; Irish potato; white potato; corn; Indian Corn; Jello (R); garbanzo; chile (powder, sauce), tomato sauce; tomato paste; kefir; pasty; Strudel. A most useful and hand dictionary for anyone interested in foods and beverages, and who can we find who is not?

GMH

"ICONOGRAPHY OF ANTARCTIC AND SUB-ANTARCTIC BENTHIC MARINE ALGAE". Part I. Chlorphycophyta and Chrysophycophyta, by Jacques S. Zaneveld, XII + 117 plates, Verlag von J. Cramer, 3301 Lehre, Germany. 1969. DM. 40. $12.00.

This collection of photographic reproductions of herbarium specimens dating mostly from the 19th Century is arranged by class, order, family, and genus under the two major divisions, the green Algae, Chlorophycophyta, and the golden Algae, Chrysophycophyta. The chief purpose of the collection of plates is to provide clear and accurate illustrations of these specimens as the next best thing to direct examination; the latter is not always convenient or possible because most of the specimens as the next best thing to direct examination; the latter is not always convenient or possible because most of the specimens are held in herbaria in northern Europe. References to the literature and an index of the plates are provided.

GMH

"CHROMATOGRAPHISCHE UND MIKROSKOPISCHE ANALYSE VON DROGEN. EINE PRAKTISCHE ERGÄNZUNG FÜR DIE ARZNEIBÜCHER EUROPAS" by E. Stahl, (Editor), VIII + 195 pp., 58 figs., 31 col. pls., 12 tabs., Gust. Fischer Verlag, Stuttgart. 1970. DM 28.--; US $8.00.

With its waterproof stiff card cover, plastic ring binding (which allows opening the book flat), and with the strong plainly printed pages, this should make an ideal laboratory manual. It truly represents a revolutionary publication in the field of pharmacognosy since it is the

first book (as far as the reviewer knows) which combines the most practical of the new and the old in the laboratory study of this subject. The old is represented by the data and drawings of powdered drugs, the new by the instructions and figures illustrating the use of thin layer chromatography. In addition, a brand new technic developed by Dr. Stahl is introduced here, "Thermomikro-Abtrenn-, Transfer-und Auftrage-Verfahren nach Stahl" (abbreviated TAS), translated into English as "Thermo-micro separation, transfer, and application procedure", which would appear to be a considerable advance in the analysis of drug materials, both in making analyses more rapidly and with greater precision. The introductory part (A) of the book entitled "Methods" gives basic information on thin layer chromatography (TLC), TAS, organoleptic tests, and micro-analysis of drug powders. Part B takes up a systematic consideration of the important drugs of the European pharmacopoeias, classed into alkaloidal, anthracene derivative, fatty oil, glycoside, resin, etc., under each monograph giving much of the information that one would expect to find in a regular textbook. Part C includes a list of reagents for micro-analysis and a list of reagents for chromatography and for other chemical tests. Finally there is an appendix of frequently used abbreviations, and then the index. One can only envy the German-speaking student of pharmacognosy with such an instructional guide since it actually serves equally well as inexpensive textbook and laboratory manual.

GMH

"HORMONES AND RESISTANCE" by Hans Selye. In two volumes ("parts"). Part 1: XVIII + 566 pp.; Part 2: VII + pp. 567-1146, 37 figs., 140 tabs., Springer-Verlag, Berlin (etc.). 1971. Cloth DM 268,--; ca. US $77.40. (parts not sold separately)

The brilliant and industrious author of this outstanding work is the Director of the Institut de Médecine et de Chirurgie expérimentales at Montréal, Québec, Canada. This is only one of his many works in the field of physiology-pharmacology-medicine; he is famous for his researches and publications on endocrinology, stress, cardiac diseases, calciphylaxis, anaphylactoid edema, and the mast cells. In the present work, he has published on the endocrine regulation of non-specific resistance to disease and to changes in the body's environment. This is really an outgrowth from studies made on the General Adaptation Syndrome (G.A.S) which is the response of the body to stress, in particular through the secretion of steroids. The protective agents have been classified into two primary groups--(a) the syntoxic compounds (mostly glucocorticoids) which by suppressing inflammation improve tissue tolerance for the pathogenic factor, and

(b) the catatoxic substances (steroids and carbonitrile derivatives) which by induction of the microsomal enzymes of the liver actively destroy the aggressor. Most of the work is devoted to group (b) since many previous studies have dealt with the first group. From a study of over 500 steroids, it seems clear that the catatoxic effect is independent from all of the regular and well known hormone actions. It is proposed that the many findings published in this work will have clinical applications for a wide variety of diseases caused by both exogenous and endogenous toxic agents. The chief purpose of the author has been to demonstrate the existence of a third G.A.S. in which a group of hormones and hormone derivatives (most of them steroids) offer resistance to agents not adequately controlled by the other two mechanisms--the immunological capacity of the serum and other tissues and the activity of autonomic nervous systems (conditioned reflexes, etc.). This work crowns the research efforts of the author over a period of 35 years. The order of topics in the text following an elaborate introduction to the plan of study is the history, chemistry, pharmacology, review of the effects of steroids on resistance, etc., effects of other hormones on resistance, etc., effect of non-hormonal factors on resistance, etc., clinical implications, morphological effects, theories, and a final evaluation. This work is a "Must"!

GMH

"STEDMAN'S MEDICAL DICTIONARY", LII + 1533 pp., 31 col. pls., 110 figs., tabs., many text figs., 11 appendices. Ed. 22, Williams & Wilkins Co., Baltimore, Md. 1972. $18.50.

This standard medical dictionary has been thoroughly revised through the activity of a staff of 33 editors, eminent professors and practitioners in human and veterinary medicine who between them have produced meaningful and precise definitions in 44 specialties and subspecialties running from aerospace medicine to virology. There are 7199 new entries, each with its pronunciation and etymological origin shown preceding the definition. These together with many revised definitions represent over 30% of the total number of terms. In other words, nearly one third of this dictionary represents partly or wholly new information. It may not be the function of such a reference work to define proprietary medicinal names, hence it may be expecting too much to find such titles as Paraben, Raudixin, and Cortef there. However, I would have liked to have seen more abbreviations presented--some of those lacking were RA (rheumatoid arthritis), SLE (systemic lupus erythematosus); SBE (subacute bacterial endocarditis), MAO (monoamine oxidase), PU (pregnancy urine), HGF (human growth factor), CV (cardiovascular), CVA (card-

iovascular accident), FEV (fluid expectorant volume), n (for gametic chromosome number), PMS (pregnant mare serum), NYGA, HLB value (hydrophile-lyophile balance), NPH (neutral protein Hagedorn (insulin)), IVP (intravenous pyelogram), CPK (creatine phosphokinase), GI (gastro-intestinal), LDH (lactic dehydrogenase), CBC (complete blood count), IRP, OHP (oxygen high pressure), GU (genitourinary). Definitions were not found for the following entry words: Stegomyia (mosquito genus); phenotropic (agent); cytoglomerator; fractionator (blood); hives, giant (angioneurotic edema); corrinoids (although corrin is given); dyskinesia, biliary; chemosterilant; anabolizing; mitodepressant (suppress mitosis, inhibit tumors); antimutagen; spiking (as referring to temperature); bile, black; spirochete (additional meaning: spiral bacterium); cavity, lung (as in TB); influenza, Spanish, London, Taiwan, Hong Kong; holozyme = holoenzyme; holoprotein; heteroprotein; syndrome, gray baby (see Drill, Phcol. IV.1736); fibrinolytic (agent); antifibrinolytic (agent); euglobin; strain, human diploid cell (for culturing polio virus); pangamic acid (vitamin B_{15}); matrix (added meaning: tablet mass). The definition of hormone, female should be broadened to include "other estrogens". The word "exocytosis" has an additional important meaning. Perhaps some vernacular names could have been defined, such as "flu". A very commendable feature of this dictionary is the use of graphic formulas for many medicinal chemical compounds. The appendices in this medical dictionary are particularly useful: 1A is a compilation of pharmaceutical preparations, with Latinized, English, and alternative names for hundreds of galenicals, compounds, and products in common use. 1A is a list of antivenins available throughout the world, with addresses of suppliers. App. 2 takes up various blood group systems. App. 3 shows Latin terms used in prescriptions. There are several other excellent appendices but the most useful of all is App. 11, the subentry index, which should be used in connection with the main body of the dictionary. This bears no definitions but only relates words which might otherwise be lost to the dictionary user. For instance, in the dictionary text, "gitter" appears only under "cell" as "cell, gitter". In some instances, there are many associated words; thus, under "gastric" there are 29 words with which this is variously combined. All in all, we have in this excellent reference work, extraordinarily complete coverage of the vocabulary of medicine and its allied sciences, including pharmacy, veterinary medicine, nursing, dentistry, etc.

GMH

"METHODENLEHRE DER THERAPEUTISCH-KLINISCHEN FORSCHUNG" by P. Martini, G. Oberhoffer, and E. Welte. 4th completely reworked edition. VIII, 495 pp., 56 tabs., 62 figs., 11 FORTRAN-Programs for electronic data processing; Springer-Verlag, 1 Berlin 33, Germany. 1968. Bound DM 148,-; $37.00 (US).

The objectives of this volume are to aid in the development of rational clinical research. The first 172 pages constitute the "General Part" which deals with the objectives, purposefulness, significance, causality, and prerequisites for medical therapeutic research and experimentation, the mathematical interpretation and usage of data, the methodology (such as the double blind procedure), the role of side effects on therapeutic research, and <u>very importantly</u> the methods of information processing, statistics, and documentation, involving mathematical interpretations, data processing with computers, and other modern technics. Much of the volume is concerned with the symbolic program language called FORTRAN (acronym for <u>For</u>mula <u>Tran</u>slation) programming for use in EDP (electronic data processing).

For the person who is more interested in specifics and the subject matter of the medical field, the second "Special Part" will be of more interest, and will represent the real meat of the book. This section covering pages 172 to 432 includes 25 chapters, each on a separate disease or group of related diseases. Application is here made of much of the methodology of Part I to specific diseases, these including both communicable (ex. acute pneumonia) and non-communicable (ex. diabetes mellitus). Let us examine one of these chapters, the one dealing with pulmonary tuberculosis, pp. 216-242. There are two main parts to the chapter: (a) collective therapeutic parallels in pulmonary TB; and (b) individual examination of the basis of the progress of the disease in pulmonary TB. Following this is a supplement on the extra-pulmonary forms of TB, such as that of the skin and lymph glands. In part (a), the bases of diagnosis are laid on (1) the presence of the micro-organism (2) the findings in the lung, *i.e.*, the organ-specific symptoms, (3) the systemic conditions, *i.e.*, the non-organ-specific symptoms, such as night sweats, and (4) the general factors which have a bearing on the disease, although not themselves pathological, such as age, sex, family history, etc. Comparative tests on series of established cases of various medicinal agents is then detailed. In part (b), individual case examination and therapy are carefully reviewed, with data on record keeping, evaluation, etc. Previous editions of this important work appeared in 1931, 1938, and 1953.

GMH

Addition to previous review:

Phytologia 27: 187; 1973.

> Omphalinae...Phaeocollybia...Strobilomycetaceae...Flora Neotropica.

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A TAXONOMIC NOTE ON *LASIODISCUS* (RHAMNACEAE)

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Lasiodiscus ferrugineus Verdc. has been treated either as a distinct species (Verdcourt, 1957; Dale & Greenway, 1961; Gillett & McDonald, 1970; Johnston, 1972) or as a synonym of *L. mildbraedii* Engl. (Drummond, 1966). Johnston (1972), while maintaining *L. ferrugineus* as a species, noted that it might not merit specific rank, although he considered it worthy of recognition at some taxonomic level.

Lasiodiscus ferrugineus has been separated from *L. mildbraedii* solely on the basis of the former's longer pubescence on the young shoots (Verdcourt, 1957; Johnston, 1972). Herbarium specimens are otherwise virtually indistinguishable. However, the capsules and seeds of *L. ferrugineus* are undescribed. These are present in a recent collection of the author: KENYA, K7, Lamu District, Witu Forest, ca. 1.5 km NW of Mambosasa Game Forest Post, ca. 2°22'S, 40°33'E, 5-15 m alt., lowland evergreen forest with *Manilkara sansibarensis* dominant, other trees noted were *Euphorbia tanaënsis*, *Cola* sp., *Ficus* cf. *bussei*, *Tamarindus indica*, *Vitex* sp., *Cassipourea euryoides*; understory shrubs were *Grandidiera boivinii*, *Rinorea ilicifolia*, *Allophylus pervillei*, *Lasiodiscus mildbraedii*, *Asteranthe asterias*, *Mallotus oppositifolius*, *Mildbraedia carpinifolia*, 19 July 1974, *Faden & Faden 74/1141* (EA, K, MO): shrub 4-5 m tall, flowers white; common. They may be described as follows: capsules depressed globose, 11-15 mm in diameter, greensih-brown, densely puberulous, 3-seeded, seeds ovoid, beige with minute darker spots and streaks, 7-7.5 mm long, 6-7 mm wide.

The capsules and seeds of *L. ferrugineus* are very similar in size, form and pubescence to those of specimens of *L. mildbraedii* in the East African Herbarium. The capsules of *Faden & Faden 74/1141* agree with the dimensions given for *L. mildbraedii* by Drummond (1966) but are significantly greater than those reported by Johnston (1972) for the same species. Perhaps the discrepancies are due to different methods of measurement. Suffice it to say, the capsules and seeds of *L. ferrugineus* are so similar to those of *L. mildbraedii* that they support Drummond's treatment of the two as conspecific. The constant difference in shoot pubescence and allopatric distributions indicate that *L. ferrugineus* merits recognition as a subspecies of *L. mildbraedii*. The following combination is required.

Lasiodiscus mildbraedii Engl. subsp. ferrugineus (Verdc.) Faden, stat. nov.
Lasiodiscus ferrugineus Verdc., Bull. Jard. Bot. État. 27: 362, 1957.

Acknowledgments

I am indebted to Miss C. H. S. Kabuye for making all the facilities of the East African Herbarium freely available to me and to the Missouri Botanical Garden and National Science Foundation (Grant No. GB-40817) for financial support for field work.

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Harold St. John
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Saxifragaceae

Broussaisia arguta Gaud., var. *arguta*, forma *ternata* Forbes ex Skottsb., Göteb. Bot. Tradg., Meddel. 2: 235, 237, 1926.

B. arguta Gaud., var. *arguta*, forma *ternatea* St. John, Pacif. Trop. Bot. Gard., Mem. 1: 169, 1973.

Skottsberg's wording, though on two separate pages, combines to make a valid publication of his new epithet. He did not indicate a type, but cited three collections, two by himself from Hawaii and Maui, and one by Forbes from Maui. In his text he states, "in the herbarium of the Bishop Museum is a specimen collected by Forbes and labelled *B. arguta* v. *ternata*." This is a good specimen with stem, leaves, and flowers. This specimen (BISH) is here chosen as the lectotype of the forma *ternata*.

Flacourtiaceae

Xylosma crenatum (St. John) comb. nov.

Antidesma crenatum St. John, Pacif. Sci. 26: 279, 281, fig. 3, 1972.

This species was described from good material with stems, leaves, pistillate flowers, and immature fruit. The tree was obviously dioecious. The collector, Robert W. Hobdy, revisited the remote locality several times during two years, without finding mature fruit or a staminate tree. Without the staminate flowers, it was hard to decide whether the tree belonged in *Antidesma* of the *Euphorbiaceae*, or in *Xylosma* of the *Flacourtiaceae*. The writer chose to put it in *Antidesma*.

Now, in a friendly letter, Dr. H. Sleumer has reported his opinion that the plant is really a species of *Xylosma*. The writer's median transverse section of a young fruit now shows the endocarp to be thin, but only slightly flattened, and

actually subterete. Fruit of Antidesma has the thick bony endocarp biconvex and nearly flat. Hence, it is concluded that the species is really one of the genus Xylosma, and the necessary transfer is made above.

Apocynaceae

Thevetia peruviana (Pers.) K. Schum., forma aurantiaca St. John, forma nova.

Diagnosis Holotypi: Corollis salmoneis Differs from the yellow flowered species by having the corollas salmon colored.

Holotypus: Hawaiian Islands, Oahu Island, Honolulu, by Teachers College Building, 4 m tall, cult., Oct. 15, 1937, H. St. John 18,402 (BISH).

Specimens Examined: Hawaiian Islands, Oahu Island, Mokuleia, Oct. 1951, O. Degener 21,461 (BISH).

Discussion: Though not previously validly published, the epithet forma or var. aurantiaca has been used by Neal, M. C., in Gardens of Hawaii 610, 1948; and by Degener, O., Flora Hawaiiensis fam. 305: 4/30/59.

A NEW *FISSIDENS* FROM MICRONESIA

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Tiny species of *Fissidens* are numerous on wetter tropical Pacific islands on shaded rocks or, less often, on roots of trees or soil banks along watercourses. It is from such habitats in the Palau Islands of the far western Pacific that this species was found. The type collection was on soft limestone rock although some other collections were from a clay hardpan exposure.

Of the species known from the lowlands of the archipelagos off the east coast of the Asian mainland, this species may be approached most closely by *Fissidens mittenii* Paris but differs in the heavier collenchymatous cell walls, the absence of somewhat elongated sub-marginal cells near the base of the vaginant lamina, and the insertion, on most leaves, of the distal end of the duplicate blade directly to the costa. The structure of the peristome would seem to place this species in the section Crispidium as circumscribed by Shin's (1964) keys. The leaf surface appears to be slightly pusticulate when the dried plants are soaked and mounted in water but specimens cleared in Hoyer's solution have no discernible surface irregularities--which may account for Iwatsuki's (1967) comment that Shin's drawings were inaccurate for that detail in regard to *F. mittenii*.

FISSIDENS DUTTONII sp. nov. (fig. 1-8)

Plantae rupestres, ca. 5.0 X 2.0 mm, foliis 6-12 jugis. Folia ca. 1.2 X 0.3 mm, acuminata; costa in apice soluta, marginibus ad apicem irregulariter dentibus et ex apice subtiliter denticulatis vel plus minusve integris. Laminae duplicatae ca. 1/3 folii extensa, limbo nullo. Cellulae laminae incrassatae, rotundatae, laeves. Dioicae. Fructus terminalis, ca. 3 mm altus, peristomio brunneolo, dentibus ca. 250 μ longis et ad apicem dense spiculatis. Specimen typicum: Palau, Babelthuap, Ngatpang, elev. 150 ft, leg. H. A. Miller 7975, 29 August 1960 (MU-*typus;* BISH, G, NICH-*isotypus*).

Plants gregarious on soft limestone or clay hardpan on moist, shaded, banks; stems to 5.0 mm tall and 2.0 mm wide with leaves. Dioicous; both archegonia and antheridia borne in clusters in terminal buds. Leaves in 6-12 pairs, including incomplete basal leaves, ca. 1.2 X 0.3 mm, the vaginant lamina extending about 1/3

Fig. 1-8. *Fissidens duttonii*. 1 - 2. Habit of fertile plant, X 17; 3. Calyptra, X 17; 4. Leaf tip, X 270; 5. Upper leaf cells and margin, X 270; 6. Habit of male plant, X 17; 7. Perigonial leaf, X 32; 8. Tip of peristome tooth, X 950.

the length; blade oblong-lanceolate with a strong, nearly percurrent, costa; margin unbordered, minutely denticulate to entire and sometimes with a few larger, irregular teeth near the tip; blade cells rounded-hexagonal, somewhat collenchymatous and incrassate with a conspicuous middle lamella in cleared material; duplicate blade free margin curved and tapering distally into the blade at the costa in most leaves, unbordered with marginal and submarginal cells isodiametric or nearly so; dorsal blade opposite the duplicate blades tapered to the stem just below the costa and somewhat decurrent down the stem; leaf tip acuminate, usually with a few irregular marginal teeth. Sporophyte single, terminal from a clearly delimited vaginula, innovations not seen; seta ca. 2.7 mm long bearing an inclined urnulate capsule with an obliquely beaked operculum. Peristome single, reddish brown, and of 16 teeth, each bifid about 3/4 and 250 μ long; the basal 1/4 of each tooth with the outer layer o bars extending the width of the tooth, and with 2-3 irregular rows of closely-spaced verruculae between each bar; the inner layer of the basal 1/4 with alternating bars extending 1/2 across the tooth from the sides, the bars lamellate in profile with irregular surface eruptions in the

undivided tooth base; the inner lamellae are coalesced to form chambers in the base of each tooth segment, the chambered portion of each segment extending for about 1/2 the segment with the chambers becoming progressively longer and less distinct as the segment narrows and bearing angled broken bars of irregular thickness extending upward to about 2/3 the segment length; distal 1/3 of each segment is coarsely spiculate-tuberculate, apparently unchambered and pale. Calyptra not seen. Named for Lee S. Dutton, botanical assistant on the Miami University--*Collegiate Rebel* Expedition.

In addition to the type, the following collections were made in the same area: Palau, Babelthuap Island above Ngatpang in forested hills about 150 feet elevation. Collected by H. A. Miller 7948, 7949, 29 August 1960; loc. cit., 400-500 feet, H. A. Miller 8017, 30 August, 1960; loc. cit., 600 feet, Lee S.Dutton 16, 69, 1 September 1960.

Grateful acknowledgement is given the National Science Foundation for Grants G-7115 and GF-176 to Miami University, Oxford, Ohio, in support of studies of Micronesian bryophytes.

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NEW NAMES AND NEW COMBINATIONS IN ASCLEPIADACEAE

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Ongoing studies of the neotropical Asclepiadaceae indicate the need for three new names and two new combinations.

CYNANCHUM PROCTORIANUM Spellman & Morillo, *nom. nov.*

Based on *Metastelma albiflorum* Griseb., Fl. Brit. W.I. Isl., 417. 1862. Type collection from Jamaica, *March s.n.*

Cynanchum albiflorum (Griseb.)Stearn, Phytologia 21: 138. 1971. Stearn's combination cannot be used because of the earlier combination *Cynanchum albiflorum* (Urb.)Woods., Fl. Trin. Tob. 2(3): 168. 1947. The species is renamed for Mr. George R. Proctor of the Institute of Jamaica, who has contributed greatly to our knowledge of the flora of that island.

MATELEA HUMBOLDTIANA Spellman & Morillo, *nom. nov.*

Based on *Lachnostoma tigrinum* H.B.K., Nov. Gen. Sp. Pl. 3: 198, tab. 232. 1818. Type collection from Colombia, *Humboldt & Bonpland s.n.*

The new name is dictated by the existence of the earlier combination *Matelea tigrina* (Urb.)Woods., Ann. Mo. Bot. Gard. 28: 226. 1941.

MATELEA MEXICANA Spellman & Morillo, *nom. nov.*

Based on *Gonolobus stenopetalus* A. Gray, Proc. Amer. Acad. 21: 398. 1886. Type collection from Mexico, *Pringle 696*.

Vincetoxicum stenopetalum (A. Gray)Standley, Contr. U.S. Nat. Herb. 23: 1190. 1924.

Matelea stenopetalum (A. Gray)Woods., Ann. Mo. Bot. Gard. 28: 231. 1941.

The new name is necessitated by the existence of the earlier combination *Matelea stenopetala* Sandw., Kew Bull. 1931: 485.

MATELEA RUBRA (Karst.)Spellman & Morillo, *comb. nov.*

Omphalophthalma rubra Karst., Fl. Colom. 2: 119, tab. 163. 1866. Type collection from Colombia, *Karsten s.n.*

MARSDENIA GLAZIOVII (Fourn.)Spellman & Morillo, *comb. nov.*

Stephanotella glaziovii Fourn. *in* Mart., Fl. Bras. 6(4): 326, tab. 96. 1885. Type collection from Brasil, *Glaziou 8804*.

NOTES ON NEW AND NOTEWORTHY PLANTS. XC

Harold N. Moldenke

xVERBENA ALLENI Moldenke, hybr. nov.

Planta hybrida; foliis caulinis inferioribus lanceolato-ovatis valde irregulariter lobatis saepe trifidis irregulariter grosse-dentatis subtus densiuscule hirtulis supra sparsiore scabro-hirtulis rugosis; foliis caulinis supremis anguste oblongis vel suboblanceolatis irregulariter laciniato-serratis; spicis plurimis valde elongatis gracillimis tenuibus dense multifloris; seminis plerumque abortis.

A natural hybrid between V. halei Small and V. xutha Lehm.; stems slender, densely pubescent; lower cauline leaves resembling those of V. xutha, lanceolate-ovate in outline, very irregularly deeply lobed, often more or less trifid, irregularly coarsely dentate, rather densely hirtulous beneath, more sparsely so and both scabrid and rugose above; upper cauline leaves mostly oblong or very slightly suboblanceolate, much smaller than the lower ones, 1—2.5 cm. long, 5—8 mm. wide, irregularly laciniate-serrate; spikes very numerous, mostly greatly elongate, to 45 cm. long, very slender and weak, densely flowered, but the seeds apparently usually mostly or all aborted.

The type of this hybrid was collected by Charles M. Allen (no. 1179) — in whose honor it is named — in an open area about 4 miles northeast of Greensburg (in Sec. 21 T2S R6E), associated with Sabatia and Stylosanthes, Saint Helena Parish, Louisiana, on July 7, 1971, and is deposited in the herbarium of the Louisiana State University at Baton Rouge. Superfically this hybrid has much of the aspect of V. runyoni, but is not at all glandular.

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ADDITIONAL MATERIALS TOWARD A MONOGRAPH OF THE GENUS CALLICARPA. XXVI

Harold N. Moldenke

CALLICARPA L.

Additional bibliography: Sonohara, Useful Trees 92. 1952; Moldenke, Phytologia 33: 480—505, 507, 509, & 511. 1976; E. H. Walker, Fl. Okin. & South. Ryuk. 883 & 888—889. 1976.

The Goreman & Katik LAE.59187, distributed as Callicarpa sp., actually is Geunsia cumingiana (Schau.) Rolfe, while Geesink & Santisuk 4937 is not verbenaceous.

Walker (1976) records "murasaki-shikibu zoku" as the Japanese

designation for this genus. He keys out the four species known from the Okinawa region as follows:

1. Resinous glands on lower leaf-surface usually dark reddish or brown . . . . C. oshimensis.

1a. Resinous glands yellowish.

  2. Lower leaf-surface densely stellate-pubescent. C. formosana.

  2a. Lower leaf-surface glabrous or stellate-pubescent, but not densely so.

    3. Leaf-blades 2—6 cm. long, 1—3.5 cm. wide. .C. dichotoma.

    3a. Leaf-blades usually larger. . . . . C. japonica.

Unfortunately, in one place the fruits are referred to as "berries", but they actually are drupes.

CALLICARPA ACUMINATA H.B.K.

Additional bibliography: Moldenke, Phytologia 33: 378--382, 404, 500, & 504. 1976.

Additional citations: COLOMBIA: Córdoba: López-Palacios 3878 (N).

CALLICARPA ARBOREA Roxb.

Additional bibliography: Moldenke, Phytologia 33: 389—391 & 498. 1976.

Recent collectors in Thailand speak of this species occurring there as scattered trees in open areas at the margins of evergreen forests, record the vernacular name, "fha", and describe the plant as having its inflorescence axes and calyx tan, the corolla-tube whitish-violet, the lobes, filaments, and style violet (Maxwell 75-765), and the fruit green and hard at first, globose, but violet or purple and juicy when ripe.

Additional citations: THAILAND: Khanthachai 252 [Herb. Roy. Forest Dept. 18183] (Ac); Maxwell 75-765 (Ac).

CALLICARPA BREVIPETIOLATA Merr.

Additional bibliography: Moldenke, Phytologia 33: 396. 1976.

On further study, it seems to me that this species does not occur in India, Bangladesh, or Thailand and the collections previously cited by me from those countries are actually C. rubella Lindl. In fact, Merrill, in his original description of C. brevipetiolata, asserts that in this species the leaf-blades are densely stellate-pubescent beneath, while in C. rubella they are merely densely puberulent beneath. I doubt very much whether this distinction is valid, but an examination of Lindley's type is necessary in order to arrive at a final decision. The two taxa are certainly extremely closely related if not cospecific.

CALLICARPA DICHOTOMA (Lour.) K. Koch

Additional bibliography: Moldenke, Phytologia 33: 400—402 & 488. 1976; E. H. Walker, Fl. Okin. & South. Ryuk. 887—889. 1976.

Walker (1976) asserts that this otherwise so common species is actually "rare" in the Ryukyo Islands, apparently known from only

a single collection.

CALLICARPA FORMOSANA Rolfe

Additional bibliography: Moldenke, Phytologia 33: 381, 405—406, & 497. 1976; E. H. Walker, Fl. Okin. & South. Ryuk. 887 & 888. 1976.

Sonohara and his associates describe this as a "rare small tree on mountains" in Okinawa and report the vernacular name, "horai-murasaki".

CALLICARPA JAPONICA Thunb.

Additional bibliography: Sonohara, Tawada, & Amano, Fl. Okin. 131. 1952; Moldenke, Phytologia 33: 483—488, 492, & 497. 1976; E. H. Walker, Fl. Okin. & South. Ryuk. 887 & 889. 1976.

Walker (1976) comments that the Japanese vernacular name for this plant, "murasaki-shikibu", "may refer to a famous beautiful woman writer, Murasaki Shikibu, this shrub suggesting her beauty. Other derivations are possible."

Additional citations: JAPAN: Honshu: Ohashi & Tateishi 483 (Ac); Tateishi 505 (Ac).

CALLICARPA JAPONICA var. LUXURIANS Rehd.

Additional bibliography: Moldenke, Phytologia 33: 487. 1976; E. H. Walker, Fl. Okin. & South. Ryuk. 889. 1976.

Sonohara and his associates (1952) record this variety from Quelpart and Oshima islands, list the vernacular names, "Japanese beauty berry", "ohmurasa-kishikibu", and "mindama-gwa", and comment that on Okinawa it is "A shrub common on mountains and plains; used for timber and fuel". Walker (1976), however, says that it is "Apparently more often found near the seacoast". He describes it as "Very similar to var. japonica. Plants sometimes small trees. Branchlets sometimes reddish brown and lenticellate, the gray outer surface disappearing. Leaves with longer petioles, 1—2.5 cm long; blade sometimes oblong, usually larger, 6—15 cm long, 4.5—8 cm wide, slightly coarser serrate. Inflorescence larger, 4—5 cm long. Flowers somewhat larger, the corolla-tube 2—2.5 mm long, the lobes 1.5—2 mm long, the anthers 2 mm long. Fruits 5—6 mm across, glossy, purple."

CALLICARPA LANCIFOLIA Millsp.

Additional bibliography: Moldenke, Phytologia 33: 482, 490, & 498. 1976.

Recent collectors in the Bahamas describe this species as an erect multistemmed shrub, 1—2 m. tall, with long sprawling branches, the stems "lightly rusty", and royal-purple fruit. They found it growing in coppice-covered hills and in the shade of hardwood coppices on ridges in cutover pineland, fruiting in November.

Additional citations: BAHAMA ISLANDS: Andros: S. R. Hill 3385 (N). Cat: D. S. Correll 46266 (N).

CALLICARPA LONGIFOLIA f. FLOCCOSA Schau.

Additional bibliography: Moldenke, Phytologia 33: 492—494. 1976.

Geesink & Santisuk describe this plant as a shrub, with the corollas, filaments, and styles pink, and encountered it in clearings and along trails in disturbed evergreen forests on limestone in Thailand.

Additional citations: THAILAND: Geesink & Santisuk 5109 (Ac), 5271 (Ac).

CALLICARPA MACROPHYLLA Vahl

Additional bibliography: Moldenke, Phytologia 33: 489, 495—497, & 500. 1976.

Geesink and his associates describe this as a medium-sized tree, the tomentum of "light ochrish-gray stellate hairs" and the corollas and filaments lilac in color. They encountered it along trails in mixed deciduous forests on limestone in Thailand.

Additional citations: THAILAND: Geesink, Phanichapol, & Santisuk 5987 (Ac).

CALLICARPA MAINGAYI King & Gamble

Additional bibliography: Moldenke, Phytologia 33: 497—498. 1976.

Recent collectors in Thailand describe this plant as a scandent shrub or small tree, 2 m. tall, the stems with a base diameter of 5 cm., the branches and leaf-veins brown-stellate, the leaf-blades green above and silvery-white beneath, the inflorescence axes tan, and the young fruit green, purple-black and juicy when mature. They have encountered it in shady evergreen and disturbed evergreen forests, along trails, and in the transition between evergreen and deciduous forests, at altitudes of 100—250 m., flowering in April, and fruiting in May.

Additional citations: THAILAND: Geesink & Santisuk 6086 (Ld); Larsen & Larsen 33432 (Ac); Maxwell 75-764 (Ac).

CALLICARPA MOLLIS Sieb. & Zucc.

Additional bibliography: Moldenke, Phytologia 33: 498—499. 1976.

Recent collectors have encountered this species on steep slopes in riverside forests.

Additional citations: JAPAN: Honshu: Kanai 731172 [Fl. Jap. Exsicc. 256] (N); Kanai & Ohashi s.n. [16 June 1973] (Ac).

CALLICARPA OSHIMENSIS Hayata

Additional bibliography: Sonohara, Useful Trees 92. 1952; Moldenke, Phytologia 33: 501—502. 1976; E. H. Walker, Fl. Okin. & South. Ryuk. 887—888. 1976.

Walker (1976) speaks of this as "A variable species" with "two scarcely separable varieties" and records the names, "oshima-murasaki" and "Amani-Oshima Callicarpa", for it. He separates the varieties as follows:

1. Leaf-blades 2.5—6 cm. long, 1—2.5 cm. wide; inflorescence about 1 cm. long. . . . . var. okinawensis.
1a. Leaf-blades 4.5—10 cm. long, 2.5—4.5 cm. wide; inflorescence 2—2.5 cm. long. . . . . var. iriomotensis.

CALLICARPA OSHIMENSIS var. IRIOMOTENSIS (Masam.) Hatus.

Additional bibliography: Moldenke, Phytologia 33: 501. 1976; E. H. Walker. Fl. Okin. & South. Ryuk. 888. 1976.

Sonohara (1952) calls this the "Iriomote-murasaki" and refers to it as "A small tree on mountains of Ishigaki, Iriomote, and Yonaguni; used as fuel". However, I regard the Yonaguni material as representing var. okinawensis.

CALLICARPA OSHIMENSIS var. OKINAWENSIS (Nakai) Hatus.

Additional bibliography: Moldenke, Phytologia 33: 501—502. 1976; E. H. Walker, Fl. Okin. & South. Ryuk. 887—888. 1976.

Sonohara and his associates (1952) call this "komoge-murasaki", describe it as "A small tree on mountains of Kunigami and Nakagami", and report that it is used for fuel there. They also assert that Nakai's binomial, C. okinawensis, was originally published as a mere nomen nudum in 1922 and is therefore invalid under the present edition of the International Code.

CALLICARPA REVOLUTA Moldenke

Additional bibliography: Fedde & Schust. in Just, Bot. Jahresber. 60 (2): 570. 1941; Moldenke, Fifth Summ. 1: 94 (1971) and 2: 855. 1971; Moldenke, Phytologia 21: 477—478. 1971; León & Alain, Fl. Cuba, imp. 2, 2: 305 & 307. 1974.

CALLICARPA RIDLEYI S. Moore

Additional bibliography: Fedde & Schust. in Just, Bot. Jahresber. 53 (1): 1071. 1925; Moldenke, Fifth Summ. 1: 321 (1971) and 2: 855. 1971; Moldenke, Phytologia 21: 477. 1971.

CALLICARPA RIVULARIS Merr.

Additional bibliography: Fedde & Schust. in Just, Bot. Jahresber. 53 (1): 1071 (1932) and 60 (2): 569. 1941; Moldenke, Fifth Summ. 1: 315, 404, & 407 (1971) and 2: 855. 1971; Moldenke, Phytologia 21: 478—479. 1971.

CALLICARPA ROIGII Britton

Additional bibliography: Fedde & Schust. in Just, Bot. Jahresber. 54 (2): 747. 1934; Moldenke, Fifth Summ. 1: 94, 414, & 416 (1971) and 2: 855. 1971; Moldenke, Phytologia 21: 479—480. 1971; Alemán Frías, Aurich, Excurra Ferrer, Gutiérrez Vázquez, Horstmann, López Rendueles, Rodríguez Graquitena, Roquel Casabella, & Schreiber, Die Kulturpfl. 19: 422. 1972; Farnsworth, Pharmacog. Titles 8 (8): iv. 1973; León & Alain, Fl. Cuba, imp. 2, 2: 304 & 306. 1974.

CALLICARPA RUBELLA Lindl.

Additional synonymy: Callicarpa rebella Farnsworth ex Moldenke, Phytologia 29: 371, in syn. 1973. Callicarpa sagaitifolia Wall. ex Moldenke, Phytologia 29: 454, in syn. 1974.

Additional & emended bibliography: Paxt., Pock. Bot. Dict., ed. 1, 57 (1840) and ed. 2, 57. 1849; Diels, Fl. Cent.-China 547—548. 1902; Brandis, Indian Trees, imp. 1, 512. 1906; H. J. Lam in H. Hallier, Meded. Rijks Herb. Leid. 37: 34. 1918; Kanjilal, Das, Kanijala, & De, Fl. Assam 3: 462, 464, & 545. 1939; Biswas, Indian Forest Rec., ser. 2, Bot. 3: 41. 1941; Fedde & Schust. in Just, Bot. Jahresber. 60 (2): 571. 1941; Graf, Exotica 3: 1482 & 1565. 1963; El-Gazzar & Wats., New Phytol. 69: 460, 483, & 485. 1970; Brandis, Indian Trees, imp. 2, 512. 1971; M. A. Martin, Introd. Ethnobot. Camb. 142. 1971; Moldenke, Fifth Summ. 1: 267, 272, 282, 287, 291, 293, 294, 299, 321, 356, 407, 410, 412, & 416—419 (1971) and 2: 709 & 855. 1971; Moldenke, Phytologia 22: 206. 1971; Chan & Teo, Chem. Pharm. Bull. 20: 1582—1584. 1972; Encke & Buchheim in Zander, Handwörterb. Pflanzennam., ed. 10, 150. 1972; Rouleau, Taxon Index Vols. 1-20, part 1: 63. 1972; Altschul, Drugs & Foods 245. 1973; Farnsworth, Pharmacog. Titles 8 (1): iii. 1973; El-Gazzar, Egypt. Journ. Bot. 17: 75 & 78. 1974; R. D. Gibbs, Chemotax. Flow. Pl. 3: 1752—1755 (1974) and 4: 2064. 1974; Moldenke, Phytologia 28: 454. 1974.

Additional illustrations: Graf, Exotica 3: 1482. 1963.

Graf (1963) describes this plant as a "deciduous shrub of loose habit, with obovate-cordate leaves lightly toothed; 4—6 in. long; numerous tiny 4-lobed pink flowers, tubular at base, in clusters, followed by profusion of lavender berries" [but the fruits are drupes, not berries!]. He gives its overall distribution as "China, Burma, Assam" and records the common name, "beauty-berry". Altschul (1973) lists it as a drug plant on the basis of Hom 00142; Kanjilal and his associates (1939) record the vernacular names, "dieng-la-khangwer", "dieng-lakso-niaw", "jalang-koai", and "soh-eitksar", describing the calyx as stellate-tomentose and the drupes as purple. They say that it ascends to 5000 feet in the Khasi hills, flowering there in the rainy season and fruiting in the cold season, the bark and root chewed by the natives like betel-nut.

Recent collectors in Thailand have encountered it along trails in disturbed forests on limestone, in open grassland, and in open grassy areas, at altitudes of 600—1700 m., and describe it as a shrublet, 2 m. tall, the corollas, filaments, and fruit violet in color. Some refer to the fruit as "berries", but actually they are drupes.

Several of the collections cited below were previously identified, distributed, and even cited by me in previous installments of these notes as C. brevipetiolata Merr., but it seems to me now that they actually represent C. rubella. Callicarpa brevipetiolata, if it is really a valid taxon, seems to be confined to Java and Sumatra.

Kingdon-Ward describes C. rubella as a shrub with purple flowers and found it growing in thickets. Martin (1971) avers that in Cambodia it is an "Arbuste de forêt dense.....vers 600 m d'altitude. Dans cette région, la racine est un substitut de la noix d'arec dans la chique de bétel", giving its distribution as "Asie tropicale" and its vernacular Cambodian name as "daəm d:h ny:".

Gibbs (1974) found syringin doubtfully absent from the leaves of this species, but cyanogenesis was definitely absent in the seeds and leaves, leucoanthocyanin is absent from the leaves; also the Ehrlich test gave only negative results in the leaves and the Juglone test also gave negative results (with blue fluorescence) in the stems and roots; HCl/methanol test results were also negative.

Additional citations: INDIA: Assam: Chand 1611 (Mi), 3202 (Mi), 5799 (Mi), 6225 (Mi); Koelz 23422 (Mi), 26044 (Mi), 32138 (Mi); Wallich 1837 (Pd). Khasi States: de Silva s.n. [Wallich 1837, in part] (Pd); Herb. Hort. Bot. Calcut. s.n. (Pd); Hooker & Thomson s.n. [Mont. Khasia alt. 4000 ped.] (M). Manipur: Kingdon-Ward 17640 (N). West Bengal: C. B. Clarke 11852 (Bz—17560). BANGLADESH: Griffith 6036 (Pd, T). CHINA: Kwangtung: Sampson 9170 (Pd). THAILAND: Charoenphol, Larsen, & Warncke 4213 (Ac), 4812 (Ac); Geesink & Phengklai 6143 (Ac); Larsen & Larsen 34450 (Ac); Larsen, Larsen, Nielsen, & Santisuk 30836 (Ac, Ld), 31659 (Ac, Ld); Maxwell 73-190 (Ac). CULTIVATED: Java: Collector undetermined s.n. (Pd); Herb. Hort. Bot. Jav. s.n. (Pd).

CALLICARPA RUBELLA var. DIELSII (Léveillé) Li

Additional bibliography: Moldenke, Fofth Summ. 1: 287, 407, & 417 (1971) and 2: 709 & 855. 1971; Moldenke, Phytologia 22: 206. 1971.

CALLICARPA RUBELLA var. HEMSLEYANA Diels

Additional bibliography: Diels, Fl. Cent.-China 547—548. 1902; Moldenke, Fifth Summ. 1: 287, 293, 407, & 417 (1971) and 2: 855. 1971; Moldenke, Phytologia 22: 206. 1971.

Hu refers to this plant as a "rare shrub" in Hong Kong, with leaves that "fall off easily".

Additional citations: HONG KONG: S. Y. Hu 7999 (W—2731298).

CALLICARPA RUBELLA f. ROBUSTA P'ei

Additional bibliography: Moldenke, Fifth Summ. 1: 291 (1971) and 2: 855. 1971; Moldenke, Phytologia 22: 207. 1971.

CALLICARPA RUDIS S. Moore

Additional bibliography: Moldenke, Fifth Summ. 1: 321 (1971) and 2: 855. 1971; Moldenke, Phytologia 21: 493. 1971.

CALLICARPA SACCATA Steen.

Additional bibliography: Moldenke, Fifth Summ. 1: 321 (1971)

and 2: 855. 1971; Moldenke, Phytologia 22: 207. 1971; Heslop-Harrison, Ind. Kew. Suppl. 15: 24. 1974.

Recent collectors describe this plant as a small tree, 10—20 feet tall, trunk girth 3—8 inches, bark surface fissured, brown with green mottling, the stems, twigs, and leaf-surfaces thickly covered with long brown or brownish hairs, "even old branches still with stiff hairs", the "lower leaf-surface" or "base of leaf lamina in most leaves on the tree" inhabited by ants, flowers "greenish" and 4-merous, calyx green, covered with long hairs, petals, filaments, and pistils white, the anthers cream or light-cream, stigma club-shaped, and the fruit bright-red. They found it growing "in disturbed primary forests on banks of small streams" or "on sandstone boulders along paths", flowering in April and both flowering and fruiting in September, and record the vernacular name, "mata ikan". They record that a "macrophotograph" of a twig was taken.

Citations: GREATER SUNDA ISLANDS: Sarawak: Chai & al. s.n. [Herb. Sarawak Forest Dept. S. 33143] (Tu, Z); G. Smith S.27725 (Kl—13873); Tong & Ilias s.n. [Herb. Sarawak Forest Dept. S. 33122] (Ac, Ld).

CALLICARPA SALVIAEFOLIA W. Griff.

Additional bibliography: Moldenke, Fifth Summ. 1: 272 & 417 (1971) and 2: 855. 1971; Moldenke, Phytologia 21: 495. 1971.

CALLICARPA SELLEANA Urb. & Ekm.

Additional bibliography: Fedde & Schust. in Just, Bot. Jahresber. 57 (2): 401. 1938; Moldenke, Fifth Summ. 1: 102 (1971) and 2: 855. 1971; Moldenke, Phytologia 21: 495 (1971) and 22: 14. 1971.

CALLICARPA SHAFERI Britton & P. Wils.

Additional bibliography: Moldenke, Fifth Summ. 1: 94 & 98 (1971) and 2: 855. 1971; Moldenke, Phytologia 21: 495—496. 1971; León & Alain, Fl. Cuba, imp. 2, 2: 304 & 306. 1974.

CALLICARPA SHIKOKIANA Mak.

Additional & emended bibliography: C. K. Schneid., Illustr. Handb. Laubholzk. 2: Reg. 20. 1912; Hara, Enum. Sperm. Jap., imp. 1, 1: 185. 1948; Moldenke, Fifth Summ. 1: 309 & 311 (1971) and 2: 855. 1971; Moldenke, Phytologia 21: 496—497 (1971) and 22: 26. 1971; Hara, Enum. Sperm. Jap., imp. 2, 1: 185. 1972.

xCALLICARPA SHIRASAWANA Mak.

Additional & emended bibliography: C. K. Schneid., Illustr. Handb. Laubholzk. 2: Reg. 20. 1912; Hara, Enum. Sperm. Jap., imp. 1, 1: 185. 1948; Moldenke, Fifth Summ. 1: 307—309, 356, 410, & 414 (1971) and 2: 855. 1971; Moldenke, Phytologia 21: 497—500. 1971; Hara, Enum. Sperm. Jap., imp. 2, 1: 185. 1972.

This binomial is very often written without indication that the plant to which it applies is a hybrid (e.g., Schneider, 1912,

Hara, 1948, etc.).

CALLICARPA SIMONDII Dop

Additional bibliography: Moldenke, Fifth Summ. 1: 299 (1971) and 2: 855. 1971; Moldenke, Phytologia 22: 13. 1971; Moldenke, Biol. Abstr. 52: 13436 (1971) and 53: 1795. 1972; Hocking, Excerpt. Bot. A.21: 116 & 117. 1973.

CALLICARPA SIONG-SAIENSIS Metc.

Additional bibliography: Fedde & Schust. in Just, Bot. Jahresber. 60 (2): 571. 1941:Moldenke, Fifth Summ. 1: 291 & 418 (1971) and 2: 855. 1971; Moldenke, Phytologia 22: 13—14. 1971.

CALLICARPA SORDIDA Urb.

Additional bibliography: Moldenke, Fifth Summ. 1: 102 (1971) and 2: 855. 1971; Moldenke, Phytologia 22: 14—15. 1971.

CALLICARPA STENOPHYLLA Merr.

Additional bibliography: Moldenke, Fifth Summ. 1: 315 (1971) and 2: 855. 1971; Moldenke, Phytologia 22: 15—16 & 23. 1971.

CALLICARPA SUBALBIDA Elm.

Additional bibliography: Fedde & Schust. in Just, Bot. Jahresber. 53 (1): 1071. 1932; Moldenke, Fifth Summ. 1: 315 & 407 (1971) and 2: 855. 1971; Moldenke, Phytologia 22: 16—18. 1971.

CALLICARPA SUBCANDIDA Elm.

Additional bibliography: Moldenke, Fifth Summ. 1: 315 (1971) and 2: 855. 1971; Moldenke, Phytologia 22: 18—19. 1971.

CALLICARPA SUBINTEGRA Merr.

Additional bibliography: Moldenke, Fifth Summ. 1: 315 (1971) and 2: 855. 1971; Moldenke, Phytologia 22: 19—20. 1971.

CALLICARPA SUBINTEGRA var. PARVA Merr.

Additional bibliography: Moldenke, Fifth Summ. 1: 315 (1971) and 2: 855. 1971; Moldenke, Phytologia 22: 20—21. 1971.

CALLICARPA SUBPUBESCENS Hook. & Arn.

Additional synonymy: Callicarpa subpubes Hook. & Arn., in herb.

Additional & emended bibliography: Hara, Enum. Sperm. Jap., imp. 1, 1: 185. 1948; Moldenke, Fifth Summ. 1: 319 & 405 (1971) and 2: 766 & 855. 1971; Moldenke, Phytologia 22: 21—22. 1971; Hara, Enum. Sperm. Jap., imp. 2, 1: 185. 1972; Hatusima, Journ. Jap. Bot. 47: 181. 1972.

Sohma and his associates found this plant in flower in May and report the vernacular name, "oba-shima-murasaki" for it.

Additional citations: BONIN ISLANDS: Chichijima: Sohma, Naruhashi, Ohba, Suzuki, & Sato 715067 (Kl—17986, W—2740520). Island undetermined: Beechey s.n. (Pd--isotype).

CALLICARPA SUPERPOSITA Merr.

Additional bibliography: Fedde & Schust. in Just, Bot. Jahresber. 54 (2): 747. 1934; Moldenke, Fifth Summ. 1: 321 (1971) and 2: 855. 1971; Moldenke, Phytologia 22: 22—23. 1971.

CALLICARPA SURIGAENSIS Merr.

Additional bibliography: Moldenke, Fifth Summ. 1: 315, 413, & 415 (1971) and 2: 855. 1971; Moldenke, Phytologia 22: 23—25. 1971.

CALLICARPA TAKAKUMENSIS Hatusima

Additional bibliography: Moldenke, Fifth Summ. 1: 309 (1971) and 2: 856. 1971; Moldenke, Phytologia 22: 25—26. 1971.

CALLICARPA TIKUSIKENSIS Masam.

Additional bibliography: Moldenke, Fifth Summ. 1: 313 (1971) and 2: 856. 1971; Moldenke, Phytologia 22: 26—27. 1971.

CALLICARPA TINGWUENSIS Chang

Additional bibliography: Moldenke, Fifth Summ. 1: 287 (1971) and 2: 856. 1971; Moldenke, Phytologia 22: 27. 1971.

CALLICARPA TOMENTOSA (L.) Murr.

Additional synonymy: Calicarpa wallichiana Walp. ex Moldenke, Phytologia 28: 454, in syn. 1974. Callicarpa integrifolia Retz. ex Moldenke, Fifth Summ. 2: 971, in syn. 1971 [not C. integrifolia Champ., 1890, nor Forbes & Hemsl., 1932, nor Jacq., 1780].

Additional & emended bibliography: Lam., Tabl. Encycl. Méth. Bot. 1: 292. 1792; Raeusch., Nom. Bot., ed. 3, 37. 1797; Pers., Syn. Pl. 1: 133. 1805; Pers., Sp. Pl. 1: 342. 1817; Paxt., Pock. Bot. Dict., ed. 1, 56 & 57 (1840) and ed. 2, 56 & 57. 1849; Schnitzlein, Iconogr. Fam. Nat. 2: 137 Verbenac. [2]. 1856; Thwaites & Hook. f., Enum. Pl. Zeyl., imp. 1, 243. 1861; Dymock, Warden, & Hooper, Pharmacog. Ind. 3: [iii] & 60. 1893; Cooke, Fl. Presid. Bombay, ed. 1, 3: 423. 1905; Brandis, Indian Trees, imp. 1, 512. 1906; Hubert, Trav. Lab. Mat. Méd. Paris 13 (4): 65. 1921; Fedde & Schust. in Just, Bot. Jahresber. 53 (1): 1071. 1932; E. D. Merr., Trans. Am. Phil. Soc., ser. 2, 24 (2): [Comm. Lour.] 332 & 418. 1935; Alston, Kandy Fl. 64, fig. 344. 1938; Fedde & Schust. in Just, Bot. Jahresber. 60 (2): 570. 1941; Cooke, Fl. Presid. Bombay, ed. 2, imp. 1, 502—503. 1958; Abeywickrama, Ceylon Journ. Sci. Biol. 2: 217. 1959; Thwaites & Hook. f., Enum. Pl. Zeyl., imp. 2, 243. 1964; P. W. Richards, Trop. Rain For. 393. 1964; Cooke, Fl. Presid. Bombay, ed. 2, imp. 2, 2: 502—503. 1967; Deb, Sengupta, & Malick, Bull. Bot. Soc. Beng. 22: 210. 1968; Gunawardena, Gen. & Sp. Pl. Zeyl. 147. 1968; A. Löve, Taxon 17: 576. 1968; Maiti, Bull. Bot. Surv. India 10: 121. 1968; Billore & Hemadri, Bull. Bot. Surv. India 11: 343. 1969; Deb, Sengupta, & Malick, Bull. Bot. Surv. India 11: 199. 1969; Hiremath & al., Journ. Karnatak Univ. [14]: 49—63. 1969; Venka-

tareddi, Bull. Bot. Surv. India 11: 258. 1969; Blasco, Inst. Franç. Pond. Trav. Sec. Scient. Tech. 10: 157 & 394. 1971; Brandis, Indian Trees, imp. 2, 512. 1971; Farnsworth, Pharmacog. Titles 6 (10): iv & title 17733. 1971; Fonseka & Vinasithamby, Prov. List Local Names Flow. Pl. Ceylon 32. 1971; Moldenke, Fifth Summ. 1: 267, 269—272, 280, 282, 287, 293, 294, 304, 315, 321, 329, 335, 338, 356, 390, 403—405, 408, 410, 412, 418, 419, & 470 (1971) and 2: 531, 643, 856, & 971. 1971; Anon., Biol. Abstr. 53 (10): B.A.S.I.C. S.35. 1972; Dymock, Warden, & Hooper, Hamdard 15: 330 & 345. 1972; Hedrick, Sturtevant's Edible Pl. 126. 1972; Moldenke, Biol. Abstr. 53: 1795, 5255, 5798, & 6372. 1972; Moldenke, Phytologia 22: 281—283 & 286—290. 1972; Rouleau, Taxon Index Vol. 1-20, part 1: 63. 1972; Farnsworth, Pharmacog. Titles 6, Cum. Gen. Ind. [22]. 1973; Hegnauer, Chemotax. Pfl. 6 [Chem. Reihe 21]: 669. 1973; Hocking, Excerpt. Bot. A.21: 117. 1973; R. R. Rao, Stud. Flow. Pl. Mysore Dist. 2: 747 [thesis]. 1973; Vartak, Bull. Indian Nat. Sci. Acad. 45: 253. 1973; Moldenke, Phytologia 25: 325 (1973) and 28: 454. 1974; Mani, Ecol. & Biogeogr, India [Illies, Monog. Biolog. 23:] 185, 240, 268, & 732. 1974; Moldenke, Phytologia 31: 389 (1975) and 33: 497. 1976.

Additional illustrations: Alston, Kandy Fl. fig. 344. 1938.

Recent collectors describe this plant as a small or low, slender, branching, rather straggling tree, 2—10 m. tall, with a trunk diameter of 12 cm., the bark light-brown and thin, the leaves green above, gray with white pubescence beneath, the flowers fragrant, the anthers light yellow-orange, and the drupes globose, at first green, then dark-purple or black, and shiny. They have found it growing in roadcuts through steep mountainsides with forest cover, on steep mountain slopes, in forest shade on cliffs, along ghat roads in wet deciduous forests, on steep forest-covered mountainsides, at the junction edge of forest and patana grasslands, on hillslopes, by waterfalls, in evergreen forests, in regions of 85 inches annual rainfall, in open sunlight near forest margins, and in wet zone forest edges. Jayasuriya reports it as "rare in tropical rain forest at low altitudes". My wife and I found it mostly occasional as isolated shrubs in hedgerows and fencerows in Sri Lanka or scattered on roadbanks and the edges of forests. Venkatareddi (1969) refers to it as "common". Thwaites & Hooker (1861) describe it as "Very common up to an elevation of 4000 feet" in Sri Lanka. Kammathy and his associates (1967) call it a "common tree in evergreen sholas and moist deciduous forests, common on margins of sholas" in Mysore; Vajravelu and his associates (1968) found it "common" in Kerala; Saldanha refers to it as a common shrub in Mysore. Deb and his associates (1969) describe it as a "middle-sized tree with mauve-coloured flowers and black fruits, on roadsides and in outskirts of forests. Widespread." It has been collected in fruit from February to June and in August, October, and December.

The corollas are described as having been "pink" on Saldanha 13382, "pinkish-mauve" on Hepper, Maxwell, & Fernando 4565,

"mauve" on Amaratunga 1341 and Worthington 5266, "pale-mauve" on Amaratunga 878, "violet" on Kostermans 23285, "purple" on Burtt & Townsend 47, Davidse 7902 & 8338, and Gould 13591, and "dark-blue" on W. D. Stevens 414. On Moldenke, Moldenke, Jayasuriya, & Sumithraarachchi 28185 the corollas and filaments were magenta. Remarkably narrow leaves are seen on Worthington 5266. Löve (1968) reports the chromosome number as n = 68, based on Mehra & Gill 1080 and as 2n = 40, based on Mehra & Gill 1022. An orthographic variant of a previously reported Singhalese vernacular name for this species is "eela-gass".

Hermann's original (1726) description of Illa is "Fol. 64. ILLA. Arbor est Malabarica, cujus cortice vescuntur Indi defectu foliorum Beteles", i.e., the bark is used as a substitute for betel-nut.

Deb and his associates (1969) give C. arborea Roxb. as a synonym of C. tomentosa, but this is incorrect. Roxburgh's species is a distinct and valid taxon. It should also be noted here that the C. integrifolia credited to Champion and to Forbes & Hemsley in the synonymy above, belongs in the synonymy of C. integerrima Champ., while that credited to Jacquin is Aegiphila integrifolia (Jacq.) Jacq.

Cooke (1967) informs us that C. tomentosa is "common on the Ghâts" of the Konkan region of Bombay, giving its overall distribution as "India (W. Peninsula); Ceylon". He notes that "The plant has some repute in native medicine.....The tomentose buds are used as wicks in oil-lamps." Trimen (1895) describes the plant as "A small or moderate-sized bushy tree, branchlets stout, cylindrical, closely covered with a thick felt (easily detached)", growing in the "Moist region [of Sri Lanka] up to 4000 ft.; very common", flowering there from March to September, the corollas "pale pinkish-lilac, anth[ers] cream-coloured". He gives its distribution as "Throughout the Indian Peninsula" and notes that "The leaves and bark are mucilaginous, and used both internally and externally. The latter is said to be also chewed." He cites Thwaites C.P.722 from Sri Lanka. Cooke (1967) cites from Bombay Cooke s.n., Dalzell & Gibson s.n., Graham s.n., Kanitkar s.n., Ritchie 570, Talbot s.n., and Woodrow s.n.; Ellis and his associates (1967) cite their nos. 18537 & 20446; Kammathy and his associates (1967) cite Barnes s.n. and their nos. 73830, 79933, & 80317 from Mysore. Venkatareddi (1969) cites Gammie 15180, 16327, & 100965, Garade s.n., and Rolla 69782 & 85238; Billore & Hemadri (1969) cite their nos. 113951 & 115618. Vajravelu (1968) cites Vajravelu 19108 from Kerala; Deb and his associates (1969) cite Sengupta 1026a, 1187, & 1428.

The Fortune 118, distributed as C. tomentosa, actually is C. kochiana Mak., while Collector undetermined s.n. [4th July 1802] is C. macrophylla Vahl.

Additional citations: NEPAL: Wallich s.n. [Bechianco] (Pd).

SIKKIM: T. Thomson s.n. [1857] (Pd). INDIA: Kerala: Collector undetermined s.n. [Canara & Malabar] (Pd); Stocks, Law, &c. s.n. (Pd). Madras: G. Thomson s.n. [Nilgiri] (Pd); Wallich 1831 (Pd). Mysore: Saldanha 13382 (W—2653638); W. D. Stevens 414 (Ln—232293); Talbot s.n. [December 15, 1881] (Pd). State undetermined: Puri s.n. [Bhimashankar, 31.3.1957] (Gz); R. Wight 638/1835 (Pd), 2314 (Pd). SRI LANKA: Alston 680 (Pd); Amaratunga 878 (Pd), 1341 (Pd); Burtt & Townsend 47 (W—2765685); Davidse 7902 (Ld), 8338 (Ld); F. W. Gould 13591 (Pd, W—2574810a); Hepper, Maxwell, & Fernando 4565 (Pd, W—2720113); Jayasuriya 1525 (Ld, N); Kostermans 23285 (Ac, N), 23520 (W—2716185); Moldenke, Moldenke, Dassanayake, & Jayasuriya 28328 (Ac, E, Gz, Kh, Ld, Pd, Tu, W—2764535); Moldenke, Moldenke, Jayasuriya, & Sumithraarachchi 28185 (Ac, E, Gz, Kh, Ld, Pd, Tu, W—2764446), 28264 (Ac, E, Gz, Kh, Ld, Pd, Tu, W—2764503); J. M. de Silva s.n. [Hantana, May 24, 1924] (Pd); Thwaites C.P.722 (Pd); R. Wight 37 (Pd), 767 (Pd); Worthington 793 (Pd), 5266 (Pd).

CALLICARPA TONKINENSIS Dop

Additional bibliography: Moldenke, Fifth Summ. 1: 299 (1971) and 2: 856. 1971; Moldenke, Phytologia 22: 283—284. 1972.

CALLICARPA TOSAËNSIS Mak.

Additional & emended bibliography: C. K. Schneid., Illustr. Handb. Laubholzk. 2: Reg. 20. 1912; Hara, Enum. Sperm. Jap., imp. 1, 1: 186. 1948; Moldenke, Fifth Summ. 1: 309 & 419 (1971) and 2: 856. 1971; Hara, Enum. Sperm. Jap., imp. 2, 1: 186. 1972; Moldenke, Phytologia 22: 284—285. 1972.

CALLICARPA TSIANGII Moldenke

Additional bibliography: Moldenke, Fifth Summ. 1: 287 (1971) and 2: 856. 1971; Moldenke, Phytologia 22: 285. 1972.

CALLICARPA VANSTEENISI Moldenke

Additional bibliography: Moldenke, Fifth Summ. 1: 321 (1971) and 2: 856. 1971; Moldenke, Phytologia 22: 286. 1972.

CALLICARPA VESTITA Wall.

Additional bibliography: Brandis, Indian Trees, imp. 1, 512. 1906; Kanjilal, Das, Kanijalal, & De, Fl. Assam 3: 462—464 & 545. 1939; Deb, Sengupta, & Malick, Bull. Bot. Soc. Bengal 22: 210. 1968; Deb, Sengupta, & Malick, Bull. Bot. Surv. India 11: 199. 1969; Brandis, Indian Trees, imp. 2, 512. 1971; Moldenke, Fifth Summ. 1: 269—272, 356, 405, 409, 411, & 419 (1971) and 2: 786, 856, & 971. 1971; Moldenke, Phytologia 22: 281, 283, & 286—289 (1972), 23: 428 (1972), and 28: 443. 1974.

Kanjilal and his associates (1939) describe the corollas of this plant as "pinkish or pale purple", record the vernacular name, "yarphu-changne", in the Khasi hills where the "Bark is

chewed like that of Careya arborea by the Duffs".

CALLICARPA VILLOSA Vahl

Additional bibliography: Raeusch., Nom. Bot., ed. 3, 37. 1797; Pers., Syn. Pl. 1: 133. 1805; Pers., Sp. Pl. 1: 343. 1817; Moldenke, Fifth Summ. 1: 272 & 408 (1971) and 2: 856 & 970. 1971; Moldenke, Phytologia 22: 281 & 289—290. 1972.

Raeuschel (1797) cites this species as from "Ind. orient."

CALLICARPA VILLOSISSIMA Ridl.

Additional bibliography: Fedde & Schust. in Just, Bot. Jahresber. 54 (2): 747. 1934; Moldenke, Fifth Summ. 1: 294 & 304 (1971) and 2: 856. 1971; Moldenke, Phytologia 22: 290—291. 1972.

Fedde & Schuster (1934) cite this species from Thailand.

CALLICARPA VIRIDIS Domin

Additional bibliography: Wangerin in Just, Bot. Jahresber. 56 (1): 668. 1936; Fedde & Schust. in Just, Bot. Jahresber. 56 (2): 285. 1937; Moldenke, Fifth Summ. 1: 344 (1971) and 2: 856. 1971; Moldenke, Phytologia 22: 291. 1972.

CALLICARPA WEBERI Merr.

Additional bibliography: Moldenke, Fifth Summ. 1: 315 (1971) and 2: 856. 1971; Moldenke, Phytologia 22: 291—292. 1972.

CALLICARPA WOODII Merr.

Additional bibliography: Fedde & Schust. in Just, Bot. Jahresber. 54 (2): 747. 1934; Moldenke, Fifth Summ. 1: 321 (1971) and 2: 856. 1971; Moldenke, Phytologia 22: 292—293. 1972.

CALLICARPA WRIGHTII Britton & P. Wils.

Additional bibliography: Moldenke, Fifth Summ. 1: 94 (1971) and 2: 856. 1971; Moldenke, Biol. Abstr. 53: 5798. 1972; Moldenke, Phytologia 22: 293—294. 1972; Hocking, Excerpt. Bot. A.21: 117. 1973; León & Alain, Fl. Cuba, imp. 2, 2: 304 & 306—307. 1974.

ADDITIONAL NOTES ON THE GENUS AVICENNIA. IX

Harold N. Moldenke

AVICENNIA MARINA var. ACUTISSIMA Stapf & Moldenke

Additional bibliography: Moldenke, Phytologia 34: 85 & 93—94. 1976.

According to Jafri (1966) this plant is very common in the Karachi area of Sind, Pakistan, being dominant in the tidal swamps with only scattered shrubs of Aegiceras corniculatus interspersed. Santapau (1967) records it from Saurashtra, India, while Rao and his associates (1966) found it on Piram island. Rao & Mukherjee (1967) report that in Saurashtra it forms a community with Salicornia brachiata in thickets and dominates parts of the shore, at Bhavnagar it is found "along sea facing low-lying shores in thickets closely followed landward by Salicornia brachiata". Shah & Patel (1970) assert that in Gujarat it is the "only mangrove seen", forming dense thickets on mud flats near watercourses. These latter authors erroneously cite "A. alba Bl." as a synonym — A. alba Blume is a separate and distinct species, as I have explained earlier in this series of notes.

Stearn found A. marina var. acutissima "on mudflats in water at high tide, left bare at low tide". Rao & Shanware (1967) found that on the sinking coast of Saurashtra this variety forms the protected mangrove coastal area with 53 percent calcium carbonate in the soil. It is one of the three pioneer plants on the muddy shores there, the others being Urochondra setulosa and Salicornia brachiata.

Khan (1961), misidentifying this plant as A. officinalis L., tells us that it is "locally known as timar" and "occurs naturally in the coastal forests of West Pakistan. It is a small tree, about 15—20 ft. high. Near Karachi in easily accessible areas it has been over exploited for firewood and fodder and in such areas it presents a shrubby appearance. It is cut for the production of firewood of cheaper quality. It is brought in boats for use in Karachi market or is used by fishermen along the coastal creeks in considerable quantities for curing of prawns during the prawn catching season from October to March each year. In addition to this, the twigs are lopped off for leaf fodder and are brought regularly in small dingy boats for stall feeding.

"Very little information is available about the silvicultural characters of Avicennia. Flowering, fruiting germination and regeneration habits were studied......Flower buds start appearing by the middle of April; flowers are yellowish pink in colour, sessile, in bracteate heads, arranged in terminal trichotomous panicles. They appear all over the coastal areas in early May. Fruits appear towards the end of July or early August and are easily available for about a month and a half. Each fruit is a one seeded cap-

sule -- about 1" to 1.25" long and compressed. About eleven seeds weigh an ounce. The seed is viviparous and some of it starts germinating while attached to the parent branch. The entire capsule is very buoyant....Very often the seed starts germinating on the mother tree and as such, the fruit along with the seed-coat is already split. Soon after, this germinated fruit falls either on the muddy ground or on the high tide water -- the radical with the tuft of fine root-hairs starts emerging out. Thus partly germinated seed or already germinated seedlings bearing the two thick cotyledons keep afloat on the tidal water in various stages of development. These are often swept away by the waves and the prevalent winds. Hence young seedlings near or under the mother tree are few and far between. The germinating seeds or young seedlings are capable of establishing themselves on suitable soil while water recedes during the low tide. The thick welldeveloped radical with tuft of hair fixes on the soil and forms side roots quickly and the cotyledons open out. Once fixed, they are sturdy enough to stand the pressure of the tidal waves during the ensuing high tide. In case the seedlings do not get fixed up on the soil before the commencement of the next high tide, they again float up and are carried away by the tidal waves elsewhere until completely destroyed or redeposited.

"The 1st pair of leaves appear in four to six days and 2nd pair of leaves in about twenty days when the two cotyledons dry out. Young seedlings normally remain completely submerged under water during high tides in their early stages of development. The seed is very viable and germination is well near 90 percent. Viability stays for a period of seven to nine days."

Jafri (1973) cites Jafri 1643, 5001, 5002, & 5003, Khan s.n. [1.5.65], Mallik s.n. [11.5.57], and Qaiser & Azmat 5489 from Sind. He records the local vernacular names, "timir" and "tivar", asserting that the plant flowers there from February to June, commenting that "It differs from *A. officinalis* L. and *A. alba* Blume, the S. E. Asian species, by its very acute or acuminate leaves, shrubby habit and slightly smaller flowers and fruits. *A. officinalis* L. and several allied taxa need a critical revision, specially with regard to leaf shape varieties, flower and fruit characters, with adequate material. The bark is said to have tanning properties and [the] leaves are used as fodder for camel and goats. It forms the dominant mangrove vegetation of [the] Karachi coast or the Arabian sea coast of West Pakistan, but appears to be under collected in our area due to difficult approach to it through swamp and mud." Patel (1971) avers that its habitat and common names are the same as for *A. officinalis* L. He misdates my Geogr. Distrib. Avicenn. (1939) as "1938" -- its actual date of publication was September 20, 1939.

Collectors describe *A. marina* var. *acutissima* as a much-branched shrub, 4--12 feet tall, with "pencil-like roots protruding from the mud for 6 inches or so", the inflorescences compact, the flowers fragrant, the corollas yellow or yellowish, and the fruit laterally compressed.

Jafri (1966) cites his no. 1643, s.n. [China creek], s.n. [Manara], and s.n. [Sand pits] from Sind, while Stewart (1972) cites Stearn 19 and H.B. 20683. Rao & Mukherjee (1967) cite Rao 2000 from Saurashtra.

It seems most probable that the "A. officinalis L." of Parsa (1949) and of Esfandiari (1967), from Iran (Kerman and Baluchistan), is A. marina var. acutissima instead.

Additional citations: PAKISTAN: Sind: Jafri 1643 (Kh); Khan s. n. [1.5.65] (Kh); Mallik s.n. [11.5.1957] (Kh); Qaiser 5489 (Kh, Kh). INDIA: Gujarat: Thanikaimoni s.n. [Gogha, 21.3.75] (Ld), s. n. [Ratara, 21.3.75] (Ld), s.n. [Mainy, 23.3.75] (Ld), s.n. [Salaya, 23.3.75] (Ld), s.n. [Navlaki, 25.3.75] (Ld), s.n. [Rann of Kutch, 25.3.75] (Ld), s.n. [Ghodbunder, 29.3.75] (Ld), s.n. [Thana, 30.3.75] (Ld). Union Territory: Thanikaimoni s.n. [Revadanta, 2. 4.75] (Ld), s.n. [Cortalin, 5.4.74] (Ld). Elephanta Island: Thanikaimoni s.n. [31.3.75] (Ld). Karumbar Island: Thanikaimoni s.n. [24.3.75] (Ld).

AVICENNIA MARINA f. ANGUSTATA Moldenke, Phytologia 23: 425, nom. nud. (1972) and 34: 18. 1976.

Bibliography: Moldenke, Phytologia 23: 425 (1972) and 34: 18 & 80. 1976.

This form differs from the typical form of the species in its much narrower leaves which are 5—9 cm. long and only 1—2.2 cm. wide. The type is Chai S.29949 from on consolidated mud near bank in front of Buntal Village, Buntal River, 1st Division, Sarawak, collected on June 18, 1971, and deposited in my personal herbarium at present in Plainfield, New Jersey.

Chai describes this plant as a shrub, treelet, or tree, 4—18 feet tall, with a 4-inch trunk girth, pneumatophores present (on individuals in consolidated mud) or absent (individuals on pure sand bars), the bark surface gray, lenticellate, "with much narrower and longer leaves than the typical form of the species also present", the flowers fragrant, the corollas yellow or orange-yellow, and the fruits glaucous-green with a blunt (flat) apex. He reports "a few trees among the sp[ecies]" on soft muddy riverbanks, in consolidated mud near the banks, on sand bars, and at the mouth of the Buntal River in front of Kampong Buntal village, flowering in May and June, also fruiting in June.

Citations: GREATER SUNDA ISLANDS: Sarawak: Chai S.29938 (Ft), S.29947 (Ld), S.29949 (Z—type).

AVICENNIA MARINA var. ANOMALA Moldenke

Additional bibliography: Moldenke, Phytologia 7: 226—227. 1960; Moldenke, Fifth Summ. 1: 349 (1971) and 2: 839. 1971.

AVICENNIA MARINA var. RESINIFERA (Forst. f.) Bakh.

Additional & emended synonymy: Avicennia resinosa Forst. apud Decne., Nouv. Ann. Mus. Hist. Nat. Paris 3: 402, in syn. 1834.

Avicennia tomentosa R. Br. ex Decne., Nouv. Ann. Mus. Hist. Nat. Paris 3: 402, in syn. 1834 [not A. tomentosa Blanco, 1845, nor Blume, 1918, nor Jacq., 1760, nor L., 1826, nor L. & Jacq., 1783, nor G. F. W. Mey., 1818, nor Nutt., 1947, nor Nutt. & Br., 1832, nor Roxb., 1835, nor Schau., 1940, nor Sw., 1864, nor Vahl, 1921, nor Weigelt, 1851, nor Willd., 1822]. ?Avicennia officinalis δ spathulata f. glandulosa Kuntze, Rev. Gen. Pl. 2: 502. 1891. Avicennia marina var. resinifera (Forst.) Bakh., Bull. Jard. Bot. Buitenz., ser. 3, 3: 210. 1921. Avicennia marina var. australasica (Walp.) Moldenke ex Beadle, Evans, Carolin, & Tindale, Fl. Sydney Reg., ed. 2, 509. 1972.

Additional & emended bibliography: Forst. f., Pl. Escul. Ins. Ocean. Austr. 72. 1786; Forst. f., Fl. Ins. Austr. Prod. 45. 1786; Raeusch., Nom. Bot., ed. 3, 182. 1797; Pers., Sp. Pl. 3: 359. 1819; Decne., Nouv. Ann. Mus. Hist. Nat. Paris 3: 402. 1834; Dieffenb., Trav. N. Zeal. 1: 431. 1843; W. Griff., Notul. Pl. Asiat. 4: 186—188. 1854; Twining, Ill. Nat. Ord. Pl. 2: 104. 1855; Drury, Useful Pl. India 57 & 490. 1858; Nutt., N. Am. Sylva 2: 144. 1865; R. Schomb., Fl. S. Austr. 52. 1875; C. B. Clarke in Hook. f., Fl. Brit. India 4: 604. 1885; Kuntze, Rev. Gen. Pl. 2: 502. 1891; R. T. Baker, Journ. Proc. Roy. Soc. N. S. Wales 49: 257—281. 1916; H. Hallier, Meded. Rijks Herb. Leid. 37: 88. 1918; Ostenfeld, Dansk Bot. Ark., ser. 2, 8: 28. 1918; Cockayne in Engl. & Drude, Veget. Erde 14: 51, 52, 56, 62, 65, & 66, pl. 4, fig. 5. 1921; Wangerin in Just, Bot. Jahresber. 51 (1): 553 (1923), 46 (1): 859 (1926), 49 (1): 521 (1928), and 50 (1): 339. 1930; Fedde & Schust. in Just, Bot. Jahresber. 53 (1): 1069. 1932; Fedde in Just, Bot. Jahresber. 49 (2): 388 (1932) and 51 (2): 259. 1933; Bakh., Journ. Arnold Arb. 16: 70. 1935; Parsa, Fl. Iran 4 (1): 536. 1949; W. C. Davies, N. Zeal. Pl. Stud., ed. 1, 126—127, pl. 48. 1956; S. P. Meyers, Mycologia 49: 489. 1957; Rageau, Pl. Méd. Nouv.-Caléd. 61, 78, 79, 81, 84, 86, 92, 104, & 113. 1957; Chapm. & Ronaldson, D. S. I. R. Bull. 125. 1958; Gilham, Austral. Journ. Bot. 8: 314. 1960; Van Royen, Nova Guinea, ser. 2, 10: 235. 1960; Allan, Fl. N. Zeal. 1: 961 & 1041. 1961; W. C. Davies, N. Zeal. Pl. Stud., ed. 2, 126—127, pl. 48. 1961; Moore & Adams, Pl. N. Zeal. Coast [104] & 105, fig. 162. 1963; R. Good, Geogr. Flow. Pl. 241. 1964; Laing & Blackwell, Pl. N. Zeal., ed. 7, 373—383, fig. 140—143. 1964; Anon., Ind. Bibliog. Bot. Trop. 4: 85. 1967; Clarke & Hannon, Journ. Ecol. Brit. 55: 753—758, pl. 13, photo 1-4. 1967; Cockayne, N. Zeal. Pl. & Story, ed. 4, 54—55, fig. 18. 1967; Cockayne & Turner, Trees N. Zeal. 33, 177, & 179, fig. 11. 1967; Kohlmeyer, Icon. Fung. Mar. 1: Anh. 5, pl. 48a & 64a. 1967; J. M. Ward, Veget. Act. Geobot. 14: 247, 249—252, 268, 273, 276, 279, 280, & 294, pl. 2, fig. 4e, 5, 14, 17, 19, 20, & 25 (2). 1967; Maxwell, Tane 14: 6, 13, & 20. 1968; Moldenke, Phytologia 15: 476 & 478. 1968; Moldenke, Résumé Suppl. 16: 15. 1968; Uphof, Dict. Econ. Pl., ed. 2, 60. 1968; H. Walt., Veget. Erde 2: 260 & 262. 1968; Anon., Biol. Abstr. 50 (9): B.A. S.I.C. S.16. 1969; Clarke & Hannon, Journ. Ecol. Brit. 57: 220.

1969; Maxwell, Biol. Abstr. 50: 4766. 1969; A. L. Moldenke, Phytologia 18: 113. 1969; V. J. Chapm., Trop. Ecol. 11: 12 & 16. 1970; Clarke & Hannon, Journ. Ecol. Brit. 59: 535—550 & 552—553. 1971; Moldenke, Fifth Summ. 1: 320, 329, 331, 334, 340, 341, 344, 349, 350, & 392—394 (1971) and 2: 839. 1971; Beadle, Evans, Carolin, & Tindale, Fl. Sydney Reg., ed. 2, 508—509. 1972; N. F. Good, Biol. Abstr. 53: 1298. 1972; Farnsworth, Pharmacog. Titles 7 (10): ii. 1972; Fong, Trojánkova, Trojánek, & Farnsworth, Lloydia 39: 147. 1972; Hedrick, Sturtevant's Edible Pl. 79. 1972; Kuchler, N. Zeal. Geogr. 28: 113—129. 1972; Anon., Biol. Abstr. 56 (6): B.A.S.I.C. S.22. 1973; N. F. Good, Biol. Abstr. 56: 4260. 1973; V. J. Chapm., Biol. Abstr. 56: 2506. 1973; Hartley, Dunstone, Fitzgerald, Johns, & Lamberton, Lloydia 36: 233 & 293. 1973; Kratochvil, Hannon, & Clarke, Proc. Linn. Soc. N. S. Wales 97: [262]—[274]. 1973; Farnsworth, Pharmacog. Titles 9 (3): iii. 1974; Gibbs, Chemotax. Flow. Pl. 3: 1752—1754. 1974; Kratochvil, Hannon, & Clarke, Biol. Abstr. 57: 761. 1974; Salmon, N. Zeal. Fls. & Pl., ed. 2, imp. 3, 23 & 227. 1974; [Farnsworth], Pharmacog. Titles 7, Cum. Gen. Ind. [15]. 1975; Moldenke, Phytologia 32: 443 & 455 (1975), 33: 240, 241, 260, & 261 (1976), and 34: 72, 75, 76, 82, 84, 85, 93, & 94. 1976.

Additional illustrations: Cockayne in Engl. & Drude, Veget. Erde 14: pl. 4, fig. 5 [as A. officinalis]. 1921; Davies, N. Zeal. Pl. Stud., ed. 1, pl. 48 (1956) and ed. 2, pl. 48. 1961; Moore & Adams, Pl. N. Zeal. Coast [104], fig. 162. 1963; Laing & Blackwell, Pl. N. Zeal., ed. 7, 374, 375, 378, & 382, fig. 140—143. 1964; Clarke & Hannon, Journ. Ecol. Brit. 55: 753—758, pl. 13, photo 1-4. 1967; Cockayne, N. Zeal. Pl. & Story, ed. 4, 54, fig. 18. 1967; Cockayne & Turner, Trees N. Zeal. fig. 11. 1967; J. M. Ward, Veget. Act. Geobot. 14: 249—252, 273, 276, 279, 280, & 294, pl. 2, fig. 4e, 5, 14, 17, 19, 20, & 25 (2). 1967; Salmon, N. Zeal. Fls. & Pl., ed. 2, imp. 3, 23 (in color). 1974.

Recent collectors describe this plant as an upright shrub, 2 m. tall, or a medium-sized tree, 5—10 m. tall, the bark gray, light-gray, or grayish, varying from smooth or fairly smooth to slightly rough, the outer bark light-brown and flakey, the wood cream-color, the leaves dark- or glossy-green above, light gray-green or silver-green beneath, aromatic, the buds green, the flowers scented, with a pleasant although rather sharp aromatic scent, abundant from February to April, the calyx green, and the fruit yellow or light yellow-green, the cotyledons deep-green. They have found it growing in mangrove and saltwater swamps, coastal marshes, mud-flats along tidal rivers, sheltered coastal mangrove swamps, and along roadsides in saltwater swamps, at altitudes of sealevel to 15 m., flowering in April, May, August, and October, and fruiting in February and April. MacDaniels 2010 is said to have been collected "on a dry hillside", but this seems hardly believable.

The corollas are said to have been "yellow" on MacDaniels 2504, "yellow-orange" on Conn & al. LAE.66147, "yellow-brown" on McKee 3153, and "dull yellowish-reddish-white" on Fosberg 30297. E. H. Walker 5352 represents a "prostrate form, mature trees 2—3 ft.

tall on typical tidal mudflats". Clarke & Hannon (1967) report that such dwarf forms are common as inliers in the Sydney district, Vernacular names reported are "bu-bula", "manawa", "mangrove", and "grey mangrove".

The accepted trinomial for this taxon was previously accredited by me to "(Forst.) Bakh.", but actually it is based on the A. resinifera of the younger Forster — Johann Georg Adam Forster (1754—1794), son of Johann Reinhold Forster (1729—1798).

Fosberg reports A. marina var. resinifera "common at edge of saltwater in low sparse forest of Metrosideros excelsa on scoria substrate" in New Zealand's North Island. Chapman (1970) proposes the ecologic association, Avicennietum resiniferae. Gilham (1960) refers to the plant as a woody perennial making up 10 percent of the dune vegetation in Victorian seabird colonies but asserts that it is not inhabited by the birds. The Gill s.n. [8 April 1970] collection, cited below, is said to be from an "area close to the most southerly edge of both mangrove and of Avicennia distribution" in the world. MacDaniels found it "frequent" in New Caledonia. Dieffenbach (1843) calls it A. tomentosa, classifies it in the Myoporineae, and asserts that it "is the Mangrove of New Zealand, covering the shallow inlets in the northern part of North Island".

It is perhaps worth noting here that the A. tomentosa of Blanco, referred to in the synonymy of this variety, is actually a synonym of A. marina var. rumphiana (H. Hallier) Bakh., the A. tomentosa of Blume is A. alba Blume, that credited to Jack, to Jacquin, to Linnaeus & Jacquin, to G. F. W. Meyer, to Nuttall, to Nuttall & Brown, to Sieber (in part), to Swartz, and to Weigelt is A. germinans (L.) L., that credited to Linnaeus, to Vahl, and to Wallich is typical A. marina (Forsk.) Vierh., that credited to Roxburgh and to Willdenow is a synonym of A. officinalis L., and that credited to Schauer is A. schaueriana Stapf & Leechman.

Decaisne (1834) describes A. marina var. resinifera as "ramis ramulisque teretibus laevibus nigricantibus; foliis subellipticis vel obovato-subtruncatis obtusis basi in petiolum attenuatis, supra laevibus nigricantibus, subtus glauco-tomentosis, junioribus tomentoso-flavidis; pedunculis angulatis tomentosis; corolla segmentis acutis; stylo brevissimo, stigmatibus subulatis." Beadle and his associates (1972) describe it as "Small trees. Leaves opposite, ovate-lanceolate to lanceolate, glabrous and shining on the upper surface, whitish below, 5—8 cm. long. Flowers in small, dense cymes on angular peduncles in upper axils or in terminal panicles. Calyx divided to the base into 5 segments. Corolla orange; tube shorter than the sepals; lobes ovate, longer than the tube. Stamens 4, inserted in the throat. Fruit a compressed capsule about 3 cm. diam. Seed solitary, without integuments; the embryo, with two large cotyledons folded longitudinally, germinates before the fruit drops. Saltwater swamps and estuaries."

Bird (1973) affirms that "Mangrove colonization has led to a

reshaping of the upper part of the intertidal profile [in the Cairns Bay area of North Queensland]. Avicennia marina [var. resinifera] has particularly promoted accretion of sediment and it is suggested that mangroves with pneumatophores are more effective in trapping sediment than mangroves with prop-roots, such as Rhizophora. The succession from mangrove to swamp forest is interrupted in slightly drier areas by the development of salt marsh." Kuchler (1973) describes the ecology of A. marina var. resinifera from the north of New Zealand to its southern limit in the middle of North Island. He states that there are relatively few strata in its ecologic association and "the floristic composition is always simple". There are six communities associated with it and "the seral status of the mangrove vegetation is emphasized. They can be reclaimed and converted to good pastures. They are not otherwise of economic importance in New Zealand." Uphof (1966), however, says that the baked or steamed fruits are eaten as food by the aborigines of North Queensland, the bark is used for tanning, producing a harsh, pale-brown, firm leather, and the wood is used for boat-building and for piles.

Twining (1855) tells us that the resin exuding from this plant was formerly eaten by the New Zealand natives. Moore & Adams (1963), on the other hand, insist that the epithet, "resinifera", "is based on an error of the first collectors, Banks and Solander, who found lumps of kauri gum floating amongst mangrove roots and believed that this resin had been produced by the mangrove trees". These modern authors give the southern limit of the tree in New Zealand as "about Opotiki and Kawhia. In North Auckland the grey trunks may be as thick as a man's body, carrying the olive-green leathery leaves thirty feet above the tide; at Tauranga the closely growing woody bushes are little taller than a well-grown crop of potatoes." They say, further: "Our mangroves grow only in muddy estuaries. About the trunks, roots of a specialized kind impede the flow of water, and the fine silt that is deposited accumulates as black, smelly, gluey mud up to four feet or more deep. Mangrove roots, like all others, need to breathe, and in the water-logged and poorly aerated mud this is achieved with the aid of special breathing roots called pneumatophores. They arise from the upper sides of horizontal roots, and push straight up until their pointed tops stand a few inches to a foot above the mud. At high tide they are surrounded by water, at low tide by air. They have spongy cortex and the thin bark is full of lenticels through which air enters. Yellowish flowers give rise to flattened fruits nearly an inch long. The velvety fruit-coat....splits soon after the fruit falls, exposing the fleshy cotyledons...that are already green and well-developed. The whole sturdy embryo is soon freed and floats with the tide until the stout hypocotyl.... has grown out and is ready to attach itself by a ring of rootlets. Mangrove plantlets, with their folded cotyledons reminiscent of the compartments of an old-fashioned purse, are familiar objects amongst light drift-wood on many Auckland beaches. Mangrove flats have their own assemblage of smaller plants and animals, lichens

on the trunks, seaweeds, barnacles, and sometimes oysters on the breathing roots, and crabs in mud holes, the whole making a natural community."

Laing & Blackwell (1964) also trace the history of the misapplied epithet, "resinifera": "Forster originally named the plant A. resinifera, from the belief that a gum chewed by the natives came from this source. This gum was perhaps kauri-gum. Lindley, in his 'Vegetable Kingdom', when speaking of the Mangrove, improves upon Forster's statement thus: 'It exudes a kind of green aromatic resin, which furnishes a miserable food for the barbarous natives of New Zealand.' (The source of the error may be traced to Croziot's 'Voyage to Tasmania'; v. Long-Roth's Translation p. 36)." Kauri-gum, it should be noted, come from a New Zealand conifer, Agathis australis, and not from an Avicennia.

Ward (1967) avers that "Chapman, in Chapman & Ronaldson (1958) believes that A. resinifera is part of the ecocline represented by A. marina (Forst.) Vierh." She also says that pneumatophores of dead A. marina var. resinifera trees remain in place and "resist erosion causing old lagoon mud to project as a ledge 6—10 inches high."

Cockayne (1967) refers to the Avicennia colonies as "one of the natural wonders of New Zealand". He continues: "Now, quite undeservedly, the mangrove has got a bad reputation. A mangrove swamp is supposed to represent all that is most hideous on earth -- alligators in crowds, a fearsome odour, crabs waiting to pick such of the victim's bones as are left by the alligators, malaria, and deadly 'microbes' in vast abundance. Even in the tropics this picture has been shown to be absurd, but in New Zealand the mangrove belt is quite a pleasing feature of the northern rivers. The mangrove is also a beneficial plant, as it materially assists in turning muddy useless shores into good dry land." He also definitely asserts that "While still on the tree....the seed has germinated." [I emphasize this and the many similar statements quoted by me previously because of the recent claim be certain writers that Avicennia differs from the other mangrove genera in NOT producing viviparous seeds].

Davies (1961) reports that in New Zealand this plant occurs on tidal flats and estuaries "from the far north to the Bay of Plenty on the east coast, and Kawhia on the west......Though the mangrove, with its insignificant flowers, sombre foliage, and muddy crab-infested surroundings at low water, is not usually regarded as an attractive member of our flora, it teems with interest for the plant-student and few can fail to be impressed by the beauty of the scene presented at high tide by the vista of partially submerged trees lining our northern tidal waterways."

Laing & Blackwell (1964) are in error when they ascribe to var. resinifera a range "Throughout Melanesia and Malaysia to India, and sporadically as far north as Mount Sinai in the Red Sea." They continue: "Mangroves have been generally regarded as the pariahs of the forest, and A. resinifera has not escaped the

usual condemnation. Thus, the following impassioned but somewhat inaccurate description as it occurs in one of the earliest New Zealand novels: 'Oh! those mangroves. I never saw one that looked as if it possessed a decent conscience. Growing always in shallow stagnant water, filthy black mud, or rank grass, gnarled, twisted, stunted, and half bare of foliage, they seem like crowds of withered, trodden down old criminals, condemned to the punishment of everlasting life.......Anyone who has seen a mangrove swamp will know what I mean.'

"Doubtless, however, much of the evil reputation of the mangrove forest is due to the fact that, to its presence, has long been erroneously attributed the prevalence of malaria in tropical river estuaries. Miasmic vapours were supposed to arise from the pestilential mangrove swamps, and spread their contagion around. Science had not then burdened the misguided mosquito with sins of transmission, as well as commission. Fortunately, New Zealand does not possess the malaria carrying mosquito (Anopheles), and so her mangrove forests, in spite of their foul appearance, are no more dangerous to human life than any other part of the country. Indeed, at high tide, a mangrove swamp is often a pleasant place to punt in, for then the somewhat sickly odour of the mud, is replaced by the fresh smell of the sea.

"Nor is the New Zealand mangrove so ugly, as those of more tropical regions. The gruesome conception of the mangrove forest existing in the minds of most people, is doubtless derived from the well-known word picture of Kingsley's Westward Ho. The passage begins: 'The night mist began to steam and wreath upon the foul beer-coloured stream,' etc. Then follows a description of the hoarse night raven, the loathly alligators lounging in the slime, the sad-coloured mangrove hens wailing sadly, and the great purple crabs crawling over the snake-like roots. Of these hideous accessories, only the mangrove-hen (the weka), and the crabs, are to be found in New Zealand.....

"The twisted and gnarled stems and roots give the tree an unwarranted appearance of age, so that even the youngest mangrove looks old. Barnacles and oysters fix themselves upon the roots which are uncovered by the withdrawal of the tide; eels wiggle in and out of their holes, and the mass of fibrous rootlets which forms a mat beneath the mud, provide dwelling places for innumerable mud-coloured crabs. These are sought after, not only by the somber-hued wekas, but also by the beautiful kingfishers. A dark-coloured fish, with curious flexible dental plates, may frequently be seen swimming over the flats at low tide."

These authors also state that "The fibrous matting [of roots] between the pegs [=pneumatophores] is rarely laid bare, save after a heavy flood, and spreads widely, forming a huge disk that prevents the mangrove from being upset. The tree is further propped up by a number of stilt roots. These, however, are not so large or so long as in the typical mangrove (Rhizophora mangle) of the tropics. The trees thus buttressed, stayed, and fixed by their varied roots, stand firm in the highest tide and the strong-

est flood, and gather about them material for a rich soil, which gradually becomes suitable for cultivation. Then they step farther out into the water and begin their work again. So far as can be roughly estimated, the mud-flats are thus raised by the action of the mangroves, on an average, a little over an inch each year. This rate of speed is probably only that of the present time, as it must have been much slower in past years before the bush was so extensively cut. Since the clearing of the land, slips have been much more frequent, and hence the rate of deposition is now faster than before."

Clarke, Lesley, & Hannon (1971), in their investigation of species interaction via phytotoxic exudates, shading, and associated growth, found that the growth of Arthrocnemum australasicum was definitely reduced and its mortality increased in association with Avicennia marina var. resinifera (as it was also with Juncus maritimus). No evidence of inhibition of Arthrocnemum by leachates or macerates of mangrove bark, leaves, or soil was found, but the higher light requirements of all of the species of Arthrocnemum zone, compared with Avicennia or Juncus, would prevent their migration into the adjacent zones where these other species are dominant. No reciprocal diminution in growth or survival of Avicennia or Juncus occurred when in association with Arthrocnemum.

McNae (1966) points out that Avicennia marina var. resinifera occurs farther south and in cooler temperatures in Australia than typical A. marina does in Africa. Sauer (1965) notes that the variety grows under a great climatic range around the periphery of the Australian continent, its sparse geographic pattern in the Sydney area probably reflecting unfavorable edaphic and exposure conditions there, where Kratochvil and his associates (1973) report that "in a few isolated areas......mature Avicennia individuals of only 1 m height occur in situations where at high tide the shoot system is completely submerged. Long, finger-like projections hand downward from the stems and are exposed to the air at low tide......Avicennia penetrates a long way inland....some plants occurring in positions that are rarely (if ever) flooded by the tide. Some individuals are very large (7.6 m tall; 46 cm D.B.H.). Some show unusual features, such as pneumatophore-like structures of 5—9 cm length projecting downwards from the trunks of the trees at distances of 2 to 6 m above ground level. Many... are unhealthy and large numbers of the 'dwarf' form occur. Contrary to Hamilton's (1919) interpretation, these 'dwarf' forms are thought to develop in areas of increased salinity."

Kohlmeyer (1967) records the fungi, Halosphaeria quadricornuta and Metasphaeria australiensis as attacking this mangrove. Maxwell (1968) adds a species of Phytophthora as attacking it in New Zealand, "perhaps derived from nearby Cupressus macrocarpa trees." It causes the death of the mangroves after symptoms of chlorotic and partially blackened leaves, severe defoliation, and dead and

moribund root tissue. Meyers (1957) also lists Metasphaeria australiensis.

Gibbs (1974) found cyanogenesis absent from the shoots of A. marina var. resinifera, the Ehrlich test negative in the leaves, and the HCl/methanol test negative.

It is also worth noting here that Baker (1916), Ostenfeld (1918) and Cockayne (1921) erroneously adopt the name, A. officinalis L., as the name for the present taxon. Laing & Blackwell (1964) give "A. officinalis" as a synonym of the present taxon, but the true A. officinalis of Linnaeus, type species of the genus, is a very different, distinct, and valid taxon (which see). Similarly, Uphof (1968) lists "A. tomentosa Jacq." as a synonym, but Jacquin's binomial actually refers to the very different New World A. germinans (L.) L.

The Griffith (1846) work cited in the bibliography is sometimes mis-dated "1851" in bibliographies.

Pételot (1954) reports on the use of this plant in the treatment of leprosy: "A la Nouvelle-Calédonie, où la lèpre s'étendait d'une façon inquiétante et où la médicine déclarait son impuissance, MM. Birard, Pharmacien en Chef de l'Hôpital de Nouméa, et F. Fruitet, Pharmacien, ont expérimenté également le traitement au Palétuvier.

"Par son abondance, par la facilité avec laquelle on peut l'administrer, par son innocuité physiologique, par la tolérance que les malades présentent pour lui et par les resultats que l'on en obtient, l'Avicennia est le meilleur remède que possède la médecine pour combattre la lèpre: a la première période 100 percent de guérison, a la deuxième période, période d'état si les viscères sont atteinte d'une façon légère, 60 percent des ces guérissent complètement dans un laps de temps variant entre 2, 3, 4 et 6 ans; les 40 percent restant, présentent une amélioration appréciable."

Rageau (1957) says: "Il a des propriétés astringentes, amêres et fébrifuges grâce á son écorce tannifère: l'écorce est encore diurétique à faible dose mais émétique et causant des céphalées intenses à haute dose; elle passe pour anti-lépreuse. L'exsudation des feuilles chauffées servirait contre les piqûres de poissons venimeux."

Van Royen (1960) cites his no. 4924, while Hartley & al. (1973) cite their no. 10293, Fedde & Schuster (1932) cite Branderhorst 227 and Versteeg 1893 from New Guinea, Robinson 1862 from the Moluccas, and Elmer 11900 and Curran 17337 from the Philippines. Bakhuizen (1935) cites Kajewski 2344 from Malaita island.

The R. A. Perry 2547, distributed as A. marina var. resinifera and so filed in some herbaria, actually is A. eucalyptifolia Zipp., while A. M. Gill s.n. [7 April 1970], in part, is A. officinalis L.

Additional citations: NEW GUINEA: Papua: Conn & al. LAE.66147 (Mu). NEW CALEDONIAN ISLANDS: New Caledonia: Baas Becking 6185

(N); MacDaniels 2010 (Ba), 2504 (Ba); McKee 2114 (W—2187229), 3153 (W—2210100). AUSTRALIA: New South Wales: Gill s.n. [7 April 1970], in part (Ft—3131); L. A. S. Johnson 24412 (W—2185581). South Australia: Dangerfield s.n. [25.XI.1963] (Mu). Victoria: Gill s.n. [8 April 1970] (Ac, Ft—9721, Ft, Ft, Ft, Ft). NEW ZEALAND: North: K. E. Adams s.n. [Feb. 1950; Herb. Bot. Div. D.S.I.R. 68986] (Z); J. H. Davis s.n. [May 1950] (W—2037461); F. R. Fosberg 30297 (W—2696435); U. Schweinfurth 1066 (Mu); P. B. Tomlinson s.n. [3 January 1969] (Ft—4414); E. H. Walker 5352 (W—1994518); K. Wood s.n. [22-6-52] (Ba). Rangitota: Trevarthen s.n. [18.2.1950] (Se—174623). GREAT BARRIER REEF: Bay Islands: Doore & Earle 276 (N, Tu—175730).

AVICENNIA MARINA var. RUMPHIANA (H. Hallier) Bakh.

Additional bibliography: Wangerin in Just, Bot. Jahresber. 51 (1): 553 (1923) and 49 (1): 521. 1928; Fedde & Schust. in Just, Bot. Jahresber. 53 (1): 1069. 1932; Fedde in Just, Bot. Jahresber. 49 (2): 388 (1932) and 51 (2): 259. 1933; Bascope, Bernardi, Jorgensen, Hueck, & Lamprecht, Inst. Forest. Latinoam. Invest. Capac. Descrip. Arb. Forest. 5, ed. 1, 13. 1959; Burkill, Dict. Econ. Prod. Malay Penins. 1: 277. 1966; Meijer, Bot. Bull. Herb. Forest Dept. Sabah 10: p. prec. 225. 1968; Moldenke, Phytologia 15: 477. 1968; Bascope, Bernardi, Jorgensen, Hueck, & Lamprecht, Inst. Forest. Latinoam. Invest. Capac. Descrip. Arb. Forest. 5, ed. 2, 13. 1970; Molden e, Fifth Summ. 1: 304, 314, 320, 329, 331, 334, 338, 339, & 392—394 (1971) and 2: 570 & 839. 1971; Moldenke, Phytologia 32: 443 (1975), 33: 239 (1976), and 34: 72, 75, 76, 84, 85, 91, 93, & 94. 1976.

Additional illustrations: Meijer, Bot. Bull. Herb. Forest Dept. Sabah 10: p. prec. 225 [as A. alba]. 1968.

Hallier (1918), in his original description of this taxon, describes it as "Ramuli novelli, petioli, laminae pagina inferior, inflorescentiae, fructus ochraceo-tomentosi. Ramuli adultiores cinerascentes, parcius tomentelli, teretes. Folia breviter petiolata, coriacea, obovata vel obovato-lanceolata, obtusa vel acutiuscula, basi acuta, nonnumquam inaequilatera, supra viridia vel fuscentia, glabra, nitidula. Florum capitula terminalia et in foliorum supremorum axillis lateralia, paniculam parvam foliosam formantia. Pedunculi quadranguli. Bracteae subtus ochraceo-tomentosae. Flores pro genere mediocres. Sepala extus glabra, olivacea vel atrofusca, margine ciliata. Fructus amygdaliformes, ovati, a latere compressi, acuti, apice nonnumquam curvati. Foliorum petiolus 0,5—2 cm longus, lamina 4,5—11,5 cm longa, 17,5 mm x 5 cm lata. Paniculae usque 6 cm longae. Capitula ca. 7 mm diametro. Fructus (an maturi?) usque ultra 2 cm longi, 1,5 cm lati." He cites Zippelius 59b from New Guinea, Forsten s.n. from Little Seran, De Vriese & Teijsmann s.n. from Buru, Forsten s.n. from Halmahera, Elmer 10451a & 12006 from Mindanao, Curran 19385 from Negros, and Ahern 116, Hallier 3522, Perrottet 819, and Vi-

dal 497 from Luzon.

Recent collectors describe this plant as a shrub, 12 feet tall, branching from the base, or a tree, 40 feet tall, the trunk 3—10 inches in girth, the bark surface pale chocolate-brown and lenticellate, the inflorescences appearing black in bud, the corollas light orange-yellow (Chai PC.3), the pistil brown, and the fruit brown-tomentose. They have encountered it in sandy mangrove areas and on "inland well consolidated soil", flowering from April to August, and fruiting in April, May, and August. Fosberg found it to be "occasional at edge of mangrove swamps at sealevel" in Sarawak.

Burkill (1966) places an "Avicennia marina var. rumphiana..... of many authors" as a synonym of A. lanata Ridl.

Fedde & Schuster (1932) cite Beguin 933 from Ternate, Teijsmann 7795 from New Guinea, Robinson 301 from the Moluccas, Ahern 116Q & 148, Curran 3536 & 19385, Elmer 10451a & 12006, Merrill 583, Miranda 18272, and Ramos 4954 from the Philippines, and Watson & Burkill 3795 from Malacca.

Material of this variety has been misidentified and distributed in some herbaria as A. intermedia Griff. and as typical A. marina (Forsk.) Vierh. The "Avicennia alba" of Meijer's illustration (1968) is probably A. marina var. rumphiana instead. On the other hand, the J. V. Santos 4748 & 5148, distributed as A. marina var. rumphiana, are typical A. marina (Forsk.) Vierh.

Additional citations: MALAYA: Selangor: Chai 4 (Kl—14967), PC. 3 (Kl—14976). State undetermined: Medway s.n. (Kl—13294). MALAYAN ISLANDS: Langkawi: Turnau 745 (Kl—2745). PHILIPPINE ISLANDS: Luzon: Gill 2 (Ac, Ft—9712, Ft), 5 (Ft—9713, Ft, Z), s. n. [16 March 1970] (Ft—9727). GREATER SUNDA ISLANDS: Sarawak: F. R. Fosberg 43820 (N, W—2638786).

AVICENNIA MIOCENICA Berry

Additional bibliography: Moldenke, Phytologia 7: 266. 1960; Moldenke, Fifth Summ. 1: 375 (1971) and 2: 839. 1971; Moldenke, Phytologia 32: 365. 1975.

AVICENNIA NITIDAFORMIS Berry

Additional bibliography: Knowlton, U. S. Geol. Surv. Bull. 696: 109. 1919; Lamotte, Geol. Soc. Am. Mem. 51: [Cat. Cenoz. Pl. N. Am.] 80. 1952; Moldenke, Phytologia 7: 266—267. 1960; Moldenke, Fifth Summ. 1: 375 (1971) and 2: 839. 1971; Moldenke, Phytologia 32: 365. 1975.

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1962, nor Miq., 1918, nor Watt, 1958].

Additional & emended synonymy: Avicennia tomentosa Willd. in L., Sp. Pl., ed. 4, 3 (1): 395. 1800 [not A. tomentosa Blanco, 1845, nor Blume, 1918, nor R. Br., 1851, nor Jacq., 1760, nor "Jacq. sensu Schau.", 1939, nor L., 1821, nor L. & Jacq., 1783, nor G. F. W. Mey., 1818, nor Nutt., 1947, nor Nutt. & Br., 1832, nor Schau., 1940, nor Sieber, 1844, nor "sensu Marc.", 1971, nor "sensu Mayc.", 1965, nor Sw., 1864, nor Vahl, 1921, nor Wall., 1851, nor Weigelt, 1851]. Avicennia obovata W. Griff., Notul. Pl. Asiat. 4: 189—190. 1854. Avicennia tomentosa Lam. apud H. Hallier, Meded. Rijks Herb. Leid. 27: 90, in syn. 1918. Anacardium orientale Jouston ex Pételot, Archiv. Recherch. Agron. & Past. Viet-Nam 18: 255, in syn. 1953. Avicenia officinalis L. apud Masamune, Sci. Rep. Kanazawa Univ. 4: 50, sphalm. 1955. Avicennia officianlis Puri, Indian Forest Ecol. 2: 225, sphalm. 1960. Avicennia officialis Por ex "A. V.", Biol. Abstr. 57: 5223, sphalm. 1974.

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Recent collectors describe this species as a tree, 4—13 m. tall, the trunk 12—54 inches in girth, the bole 5 m. tall, with a diameter of 15 cm. at breast height, with pneumatophores and sometimes also with stilt-roots (prop-roots), shoots often to 15 feet tall from old stumps, the bark surface smooth, pinkish-gray or gray to brownish-gray, very thin, brittle, not fissured or narrowly cracked horizontally, the inner bark white, spongy, 2 mm. thick, the wood white, with the cylinders of soft tissue very conspicuous, the leaves dark-gray or dull-green above, rounded at the tip, green or gray-green to pale gray-brown beneath, the sepals dark-green, the petals 4 or 5, the stamens 4, yellow, brown-tipped, the anthers yellowish, turning black, the style greenish-brown, and the fruit a short capsule, green or pale-brown, covered with brown or shiny-brown to dark yellowish-brown tomentum.

The corollas are said to have been "yellow" on Chai S.30643 and Fosberg 36953, "bright-yellow" on Chai & al. S.26712, "dark-yellow" on Stone 5930, "cream, yellow inside" on Streitmann & Lelean NGF.18468, "pale-orange" on Darbyshire 784, and "orange" on Jayasuriya 1356.

The species has been found by collectors in mangrove swamps, disturbed mangrove areas, brackish swamps and mangrove deltas, and in sandy mud or water at the margins of mangrove swamps, on lagoon margins, at the edge of canals, on well consolidated soil near riverbanks, and on inland well consolidated soil by lagoons, in region of up to 60 inches rainfall, from sealevel to 3 m. altitude. They have collected it in anthesis in March, April, June, July, September, and October, and in fruit in March, July, August, and December.

The Streitmann & Lelean NGF.18468 collection was taken from a

"damaged tree with solid bole and numerous suckers"; *Jayasuriya 2824*9 was also taken from a deformed tree. Womersley encountered the species in a mangrove forest dominated by *Rhizophora apiculata*, *Bruguiera gymnorrhiza*, *B. parviflora*, and *Xylocarpus granatum*, with an understory of *Nypa fruticans*.

A large number of common and vernacular names occur in the literature, but many of these probably really apply to *A. alba* Blume, *A. marina* (Forsk.) Vierh., *A. marina* var. *acutissima* Stapf & Moldenke, *A. marina* var. *resinifera* (Forst. f.) Bakh., or *A. marina* var. *rumphiana* (H. Hallier) Bakh., all of which taxa have frequently been confused with and misidentified as *A. officinalis* L. in the field and in the herbarium. Among those apparently genuinely applied to *A. officinalis* are "afi-afi", "api-api", "api-api brajoe", "api-api daum lebar" (=api-api with broad leaves), "api-api katjang", "api-api ludat", "api-api puteh" (white api-api), "api-api sudu", "apie-apie", "baen", "báen", "bakal", "bani", "bina", "cher", "cheria", "cheriya", "delena", "ipati", "kajoeting",

Fig. 1. *Avicennia officinalis*, showing pneumatophores and prop-roots. Sg. Santoboug, January 21, 1976 (photo courtesy of P. Chai)

"kujuh apie-apie", "kanna", "kari", "ki blanak", "ludat", "mada", "mada-chettu", "madda", "mắm", "mắm den", "manggi-mangiggi poetih", "mangrove", "nalla-mada", "palétuvier blanc", "palétuvier gaïac", "pèpé-pèpé", "purunde-mara", "sa-mae-tha-le", "tavar", "tavariya", "tavariyan", "tavra", "tavri", "tereh-tereh", "thame", "timar", "timmar", "tioes léwo", "tivar", "tivara", "tiwar", "udat",

"upatha", "upputi", "wata koemban", "white mangrove", and "white mangrove tree". "Hirugidamasi" and "hirugi-damashi" are recorded by Sonohara and his associates (1952) and by Masamune (1955), but surely apply to A. marina instead, as does their recording of A. officinalis from Iriomote, Ishigaki, Komi, Miyako, and Obama. Masamune also avers that A. officinalis has a natural distribution of "Taiwan; Fukien (?) to tropical Asia", but the species actually is not known from either Formosa or China. The vernacular names listed by Glover (1947) also apply, not to A. officinalis, but to A. marina.

The wood of A. officinalis is said to be known as "bakol" in the trade.

Tan & Keng (1969) report that in the vasculature of the [usually] 4-lobed corolla of 3 of the 4 species investigated three species have 4 traces each supplying one corolla-lobe, but in A. officinalis an additional trace runs into the posterior corolla-lobe. This suggests that the present 4-lobed corolla of the genus is probably derived from a 5-lobed ancient form and this is further borne out by the fact that 5-lobed corollas are occasionally found in A. officinalis. These authors also point out that even

Fig. 2. Avicennia officinalis, showing pneumatophores and prop-roots. Sg. Santoboug, January 21, 1976 (photograph courtesy of P. Chai)

though A. intermedia W. Griff. was originally proposed as a natural hybrid between A. officinalis L. and A. alba Blume, "seed-

lings of this species are uniform, and do not reveal any hybrid nature. Although the pollen-grains exhibit intermediate characters between A. alba and A. officinalis, they are mostly well-filled, rather than empty, thus suggesting that it is a distinct species [now known as A. marina (Forsk.) Vierh.]."

Fig. 3. Avicennia officinalis, showing prop-roots (photograph courtesy of P. Chai)

Mallik & Chaudhuri (1968) describe the pollen of A. officinalis as "3-colporate grains, prolate, 32 mu — 39 mu x 22 mu — 34 mu, exine 2.5 mu thick, reticulate, nexine thick at colpi margin, colpi 30 mu in length, 5 mu broad, crassimarginate, ora lalongate, mesocolpium diameter 19 mu."

Mukherjee & Chanda (1973) describe the wood of A. officinalis as having "distinct growth rings, which are diffuse porous and non-storied. Simple perforated vessels are generally multiple, 2—3

in radial sequence, diameter 20 mu — 100 mu and 150 mu x 40 mu in size. Fibres 300 mu — 350 mu x 20 mu — 25 mu in size, aseptate. Axial parenchyma with paratracheal vesicentric and apotracheal boundary parenchyma of 2—4 cells, thick layers having crystals. Multiseriate, /heterogenous rays are 260 mu — 480 mu x 32 mu in size."

These same authors describe the pollen grains as being the same

Fig. 4. Avicennia officinalis, showing prop-roots (photograph courtesy of P. Chai)

in all the species studied (viz., A. eucalyptifolia, A. marina, A. officinalis, and what they call "A. tomentosa Roxb.", by which they probably mean, in this case, A. alba): "tricolporate; colpi about 25 mu x 5 mu (range 22 mu — 35 mu x 4 mu — 5.5 mu) with thin margin. Ora lolongate, confined within the limits of colpi, about 9 mu x 5 mu (range 5 mu — 12 mu x 3 mu — 6 mu). Mean intercolporal distance 13 mu. Amb convex. Sexinal part of

exine projected outward, and devoid of any ornamentation. Mean apocolpium diam. 11 mu. Prolate-spheroidal to spheroidal, P/E about 32 mu x 31 mu (range 27.5 mu — 36 mu x 26.5 mu — 36 mu). Exine 3.5 mu thick. Sexine 2.5 mu thick, reticulate, intectate, muri simplibaculate, rarely duplibaculate, heterobrochate, lumina polygonal, dimension gradually becomes smaller towards the aperture. Bacula provided with distinct globular knoblike head. Nexine 1 mu thick, tenuiexinous. NPC classification 345."

Fig. 5. General view of Avicennia officinalis forest in Sarawak (photograph courtesy of P. Chai)

Chai (1972) describes A. officinalis as it occurs in Sarawak: "Small to medium-sized tree —55 ft. tall. No buttresses but stilt roots may be present. Bark surface brownish-grey to chocolate-brown, lenticellate, may be narrowly cracked. Leaf spatulate or spoon-shaped, lower surface very light brown; salt excretion from upper surface. Fruit more or less heart-shaped, slightly flattened, beaked, covered in soft, brown tomentum. Occurrence: Commonly inland but not gregarious, along river or creek banks on stiff heavy soils; absent or very rare on the sea face. Associated with low and light crowned species like Nypa and young Rhizophora and Bruguiera." He keys out the three species known to him in Sarawak as follows:

1. Small shrub (3 feet tall) to large tree (to 60 feet tall), the old bark grayish-pink or pinkish-brown, coming off in patches of irregular thin flakes, revealing the green new bark; leaf-shape elliptic; inhabiting sandy soil............A. marina.

1a. Medium to large tree, to 70 feet tall, the bark dark-gray to

black, not flaky; leaf-shape lanceolate; inhabiting soft mud...A. alba.

1b. Small to large tree, to 55 feet tall, the bark gray to chocolate-brown, often lenticellate; leaf-shape spatulate or oblong-obovate; inhabiting inland areas often on firm riverbanks..................................A. officinalis.

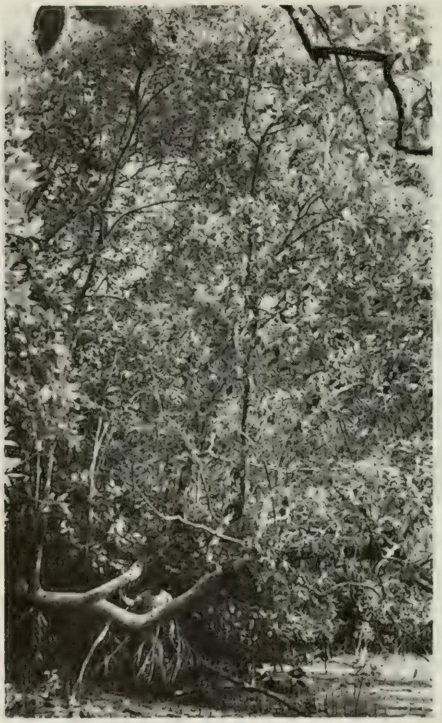

Fig. 6. Avicennia officinalis, showing prop-roots and pneumatophores (photograph courtesy of P.Chai)

Fosberg found A. officinalis "common in interior of swamp" at Singapore, while Mcnae reports it "at rear of Avicennia fringe along lagoons" in Sri Lanka. Puri (1960) and Chapman (1970) aver that A. officinalis sometimes grows in A. alba Blume communities in the Sunderbans of Bangladesh. There it may occur in association with Bruguiera gymnorrhiza, Carapa moluccensis, Heritiera minor, Sonneratia apetala, and S. arida.

According to Uphof (1941) _A. officinalis_ has been cultivated (in pots) in the Hamburg Botanical Garden, Germany. Chapman (1970) proposes the ecologic association Avicennietum officinale. The embryology of the species is thoroughly discussed by Padmanabhan (1964): "The first division of the primary endosperm nucleus is followed by a transverse wall. The upper chamber again divides transversely leading to the formation of a row of three cells including the primary chalazal chamber which forms a uninucleate

Fig. 7. _Avicennia officinalis_, showing prop-roots (photograph courtesy of P. Chai)

chalazal haustorium. The micropylar chamber divides vertically to give rise to a two-celled micropylar haustorium while the middle cell forms the endosperm proper. The micropylar haustorium cells become multinucleate, one of them containing eight and the other having four nuclei. The cell with eight nuclei forms an aggressive haustorium growing through the ovular tissues towards

the chalaza putting forth numerous lateral branches and then into the placental column where the branches become much more extensive and ramify into the tissues. The endosperm proper grows out of the ovule carrying the embryo with it; thus a major part of the cellular endosperm and the embryo embedded in it come to lie in the locule, where their further development takes place. In older stages of development, the two cells of the micropylar haustorium develop plasmodesma-like connections. Similar connections are also established with the contiguous endosperm cells. The growth of the haustorial branches in the ovule and placental column is strictly intercellular."

Fig. 8. General view of Avicennia officinalis forest in Sarawak (photograph courtesy P. Chai)

Avicennia officinalis is the type species of the genus. Gunawardena (1968) reminds us that the medicinal value of the species was recognized even in Linnaeus' day, as is shown by his use of the specific epithet, officinalis (from officina, a druggist's shop, indicating that the plant was to be found in pharmacies in his time).

Clarke (1885) gives the species' distribution as "Mangrove swamps of the Deccan Peninsula [of India] and Ceylon, common; less frequent in the Malay Peninsula.....Malaya, Shores of the Indian and Pacific Ocean." Benoist (1931, 1933) mistakenly records it from French Guiana — it does not occur in the New World. Guha Bakshi & Sen (1969) record it from Sagar Island (West Bengal, India), citing their no. 53. Santapau & Shah (1969) list it from Salsette Island. Foreman (1972) records it from Bougainville Island, citing Rechinger 4927. The Foreman work is

sometimes cited in bibliographies as "1971", the title-page date, but it was not actually published until 1972. Inamdar (1971) lists A. officinalis from Gujarat, India.

Agarwal (1970) gives its range as "Distributed in Bengal, Coastal and tidal forests of India & Burma, Andaman and Nicobar Islands". He describes the wood as "brownish gray, hard", with a weight of 26.30 kgm. per cubic foot, asserting that it is "Used generally as fuel or firewood and in Andaman Islands for rice-pounders." Gaussen and his associates (1967) affirm its value in serving as a colonizer of intertidal zones and estuaries. Hartwell (1971) asserts that the fruit is used in India to make plasters used in the treatment of tumors. In Thailand, according to Rativanich & Dietrichs (1971) the heartwood is employed as a vomitive and poison counteractive, as well as to treat coughs, asthma, rickets, diabetes, dropsy, gonorrhea, diarrhea, and dysentery, the sapwood is used as a snake venom counteractive, and the bark is employed in the treatment of leprosy.

Cook (1906) tells us that "Though the bark possesses tanning properties and is said to be used as a tanning material in Rio Janeiro, it does not seem to be so employed in India." Actually, the species does not occur in Brazil, nor anywhere else in the New World. The Rio de Janeiro species here referred to is probably A. schaueriana Stapf & Leechman, the commonest species in the vicinty of that port city. Similarly, Sonohara and his associates (1952) report that the bark of A. officinalis yields a resin on Okinawa, but the species does not occur there -- the species to which he is here referring is A. marina (Forsk.) Vierh.

Thwaites & Hooker (1861) report A. officinalis "Not uncommon near the sea" in Sri Lanka, but Alston (1931) regards it as "rare" there, A. marina being the common species there. Arulchelram (1968) describes A. officinalis as it occurs in Sri Lanka as "A small tree with a straight trunk. Bark, gray or black, young twigs quadrangular and finely pubescent. Leaves yellowish green above and silvery white beneath, with dense, fine pubescence. 2 1/2 to 4 inches long by 1 1/2 to 2 1/2 inches broad. Elliptical, apex rounded with 6 to 9 opposite or subopposite lateral veins. Other characters similar to Avicennia marina." He completely misses the very important differences in flower size.

Hallier (1918) found A. officinalis growing in association with Ceriops roxburghiana, Allophylus sp., Clerodendrum inerme, Hibiscus sp., Wedelia biflora, Cerbera odollam, Heteropterys sp., Glochidium sp., Acanthus ilicifolius, Pluchea indica, Premna foetida, and Acrostichum aureum. He cites Wight 2328 and Hohenacker 68 from India, Hallier B.271 from Borneo, Junghuhn s.n. from Java, Teijsmann 1753 from Madura, Elbert 2701 from Buton, Versteeg 1887 from New Guinea, and Hallier 3521 and Perrottet s.n. from Luzon. Interestingly he gives the following argument for discarding Linnaeus' epithet for this species: "Daraus, dass Linné seine A. officinalis in die Klasse Tetrandria gestellt hat, zog Buch.-Hamilton den Schluss,

dass ersterem thatsächlich Blütenzweige einer Art der Gattung Avicennia aut. vorgelegen hatten. Da aber keine Art dieser Gattung jemals offizinell war, so kann sich die Arbeitzeichnung officinale nur auf das Synonym Anacardium Bauh. (=Semecarpus Anacardium L. f.) beziehen. Der von Linné gegebene Artname ist also nicht brauchbar und Hamilton hat der Pflanze von Vorderindien mit vollem Recht einen neuem Name gegeben. Durch wiedereinführung des letzteren wird die ganz später noch erheblich vermehrte Unsicherheit der Namengebung beseitigt." I regard Anacardium Bauhin as a synonym of Avicennia alba Blume.

Rao, Aggarwal, & Mukherjee (1963) found A. officinalis growing with Atriplex repens in an inland creek habitat on soil that was "dull white coloured with a pinkish tinge" and with a pH of more than 8.2, with 0.503 percent organic matter, 0.177 percent soluble salts, 0.12 percent NaCl, and 70.59 percent calcium carbonate.

Santapau (1967) records the species from Saurashtra, India. Esfandiari (1967) and Parsa (1949) list it from Iran ("Kerman" and "S-E Baloutchestan"), but, although I have not as yet seen any Avicennia material from Iran, it seems most probable that the taxon to which reference is here made is A. marina var. acutissima Stapf & Moldenke, the only form known from neighboring Sind in Pakistan, from which I have seen abundant material.

Backer & Bakhuizen (1965) list A. officinalis as one of the species "sometimes planted between and along coastal fish-ponds" in Java and comment that "The wood is of very inferior quality, and is almost exclusively used for fuel. This tree is often spared in localities where producers of better wood are continually felled, consequently in the course of time there may locally arise an almost pure Avicennia forest. Such forests are in Java always anthropogenous; they constitute a climax-form of selective devastation of litoral forests coupled with spontaneous regeneration, and are found only in inhabited regions."

These authors describe the species well: "Expanded flowers 10—15 mm across; corolla from the base of the tube up to the tops of the segments measuring 7—10 mm; posterior segment broadest, shallowly bilobed; stamens (inclusive of anthers) 3.5—4.5 mm long; ovary densely appressed-pubescent throughout; style subulate, pubescent throughout or at least at base, 3—4 mm long; stigmatic lobes much shorter than the rest of the style, often unequal; fruit acuminate, densely short-hairy. Flowers to the number of 2—12 congested into a head; lowermost pair of flowers often distant from the other ones. Leaves obovate, oblong-obovate or elliptic-oblong, narrowed into the petiole, rounded or very obtuse, yellowish green or bluish gray beneath, 4—12.5 cm by 2—6 cm." They assert that in Java it grows "especially along riverbanks" in the coastal area.

Monsalud and his associates (1966) assert that in the Philippines the fruits and leaves of this species are "Eaten either raw or cooked", and describe the tree as it occurs there as "of the

outer part of the swamp. Bark usually light gray or brown and rather smooth but finely checked by small cracks. Air roots numerous, small, conical and 8 to 20 cm. long. Leaves leathery, opposite, dark green above, very pale and hairy beneath, usually somewhat rounded at apex, narrow at base, midrib stout and very prominent. Flowers small without individual stalks and in small heads on stiff angular flowering stalks. Flowers 3 to 7 in each head. Corolla orange yellow. A capsule fruit 2.5 to 4 cm long and contains a single seed which completely fills the capsule. Found throughout the Philippines along muddy shores and tidal streams." Actually, its flowers are the largest of all the Philippine species.

Burkill (1966) describes A. officinalis as "A tree attaining 60 feet in height, sporadic on the banks of rivers in their course through the mangrove-belt. Outside Malaya, it extends from Persia to Hong Kong and to New Guinea." However, this species is not actually known from Persia [see above] or Hong Kong — A. marina (Forsk.) Vierh. being thus misidentified in the latter case and A. marina var. acutissima Stapf & Moldenke in the former.

Rao & Sastry (1972) affirm that in at least some parts of the Indian coast A. officinalis grows in association with Pemphis acidula, Cordia subcordata, Atriplex repens, Salicornia brachiata, and Suriana maritima under seawater inundation.

Angely (1971) is in error when he states that A. officinalis is "Pantropical" in distribution — actually it does not occur in the American or the African continents at all. Lamberti (1969) also makes the error of including the distribution of A. marina and A. marina var. resinifera with that of A. officinalis — A. officinalis does not occur in East Africa, Madagascar, Japan, China, or the "Ilhas sul Japonesas" as he says that it does!

Patel (1971) asserts that in Gujarat, India, A. officinalis is a tree, contrasted to A. marina var. acutissima being only a "shrub". He describes the former as "A small tree with smooth bark, shining leaves and yellow flowers. Grows in muddy creeks along the coast. The leaves are eaten by cattle." He aserts that in Gujarat it flowers from March to June and fruits from June to September. Cooke (1906) avers that in Bombay it flowers from April to June.

Troup (1921) provides another interesting description: "A large evergreen shrub or small tree of the mangrove swamps along the coasts and tidal creeks of India and Burma. It is one of the commonest of the Indian mangrove species, growing gregariously, and often forming an extensive bushy growth, conspicuous from its grey foliage [this applies far better to A. alba and A. marina with which it is often associated!], and when in flower from its bright yellow inflorescences. In the Sunderbans it occurs in the inland parts of the littoral forest, and is characteristic of bhils, or moist depressions. It is common along the coasts of both sides of the Indian Peninsula as well as of Chittagong [Bangladesh], Arakan, and Burma. In the Sittang estuary it sometimes forms 60 or 70 per-

cent of the stock, and reaches a height of 25—30 ft. with a girth of 2—3 ft.

"The wood has a peculiar structure, consisting of alternate layers of pore-bearing tissue and loose large-celled tissue without pores. It is brittle, and is used only as fuel, but in some localities it is an important fuel species.

"The panicled heads of yellow flowers appear from March to June, and the fruit ripens from August to October......The seeds germinate immediately they fall, or even on the tree....The seeds are buoyant, and are thus able to spread by the agency of water; about October the tidal creeks are often full of the large seeds floating on the surface of the water, and most of this seed will be found to be germinating. To collect the seeds for artificial reproduction, the best method is to drag with a small net, and throw the seed into a canoe, partly filled with water, which should then proceed straight to where the seed is to be sown without delay. In Madras it is usual to sow the seed broadcast, the best time being between new moon and full moon, when the tides are lowest; the sowing is done when the tide has run out and there is no water on the ground, otherwise there is danger of the seed floating away.

"Under favourable conditions the tree regenerates freely from seed. The necessary conditions appear to be frequent flooding and absence of dense low cover, which the seedlings do not tolerate. Thus the lowering of the water-level results in a cessation of reproduction, while a dense growth of Acanthus ilicifolius, prevalent in some localities, tends to kill out the seedlings. The tree does not coppice well. Its lateral roots spread in all directions through the mud in which it grows, and send up a plentiful crop of pneumatophores. Mr. A. W. Lushington has observed that in the Kistna mangrove forests these ultimately develop leaves and become trees. This has not been recorded in any other locality, but in view of the poor coppicing power of the species it is a question of importance which requires further investigation in different localities."

Kräusel (1931), quoting Emould's (1921) detailed work on respiratory roots, speaks of the anatomy of the "Luftwurzeln" of mangroves: "Sie weisen gewisse gemeinsame Merkmale auf. So besteht die Rinde stets aus einem reich entwickelten Parenchym mit zahlreichen Interzellularen, die bei manchen zu grossen radialen Spalten werden können, und ebenso ist stets eine Verbindung mit der Aussenluft vorhanden......durch Lenticellen [Avicennia officinalis, Bruguiera gymnorrhiza, Lumnitzera, Carapa] oder Pneumathoden [palms]."

Sen Gupta (1938) reports the measured osmotic pressure in Avicennia officinalis as 25.92. Cooper & Pasha (1935) found that the "suction pressure" is greatest in the leaves, medium in the stem, and lowest in the roots, with a marked increase noticed from August to October in India. They agree with other workers that in halophytes such as this there is a more vigorous transpiration than is found in mesophytes. It is possible that the rise in the

suction pressure is brought about by this vigorous transpiration rate which may bring about greater absorption of salts along with the water in the cells. The physiological anatomy, as compared to that of A. alba and of mangroves of other genera, was also reported on in detail by Mullan (1932).

Estores Anzaldo and his associates (1958) found that the leaves of A. officinalis give a negative hemolysis test for saponins, but that the stems give a positive saponin test with an estimated steroidal sapogenin content of 0.52 percent.

Nairne (1894) says of the species: "Very common in salt marshes [of western India]; in black rocks covered by every tide it grows as a stunted shrub, and is said to grow in the same way on the coasts of the Red Sea, Africa, Australia, and S. America." This, of course, is not true, since A. officinalis does not grow in either the Red Sea area, Africa, or South America — the Red Sea and African plant is A. marina, while that of South America may be any of six species and varieties.

Trimen (1895) found A. officinalis "in shallow salt water or sandy tidal flats on the coast [of Sri Lanka]; common". He claims that it flowers there from August to October, with "pale dull yellow" flowers. He also makes the claim that its natural distribution is "Throughout Tropical Asia, Africa, and America", but, again, the species does not occur in either Africa or America. He continues: "There is no specimen or drawing in Herm. Herb. This is one of the trees known as mangroves, and is often called 'white mangrove'. The large embryo usually germinates in the fruit before it falls, but the tree has no stilts. It often occurs over large tracts of tidal or flooded shore to the exclusion of all other plants, as dwarf bushes half covered at high water. Its roots bear great numbers of erect processes (like those of Sonneratia), the points of which stand above the shallow water; these are capable of producing leaves and growing up into bushes, but rarely do so......When dry, the leaves turn black above and silky-white beneath [this statement applies to A. marina, not to A. officinalis!]. The bark is astringent, and might be used for tanning purposes."

Dymock (1893) comments that "The green fruit mixed with butter and boiled is made into a plaster, which is used for softening and maturing tumours, and to promote the healing of the ulcerations caused by small-pox. This property of the fruit is alluded to by Camoens in the 'Lusaid' —

'Wide forests there beneath Maldivia's tide
From withering air their wondrous fruitage hide.
The green-hair'd Nereids tend the bowery dells
Whose wondrous fruitage poison's rage expels.'

"The bark is astringent and is used by tanners. In Madras the ashes of the wood are used by washermen for washing clothes. The wood is valued on account of its durability under water, and as a fuel for heating furnaces it is preferred to other kinds of wood on the West Coast of India. The seeds are bitter, but are sometimes eaten......The bark of A. officinalis is used in Madras as

a dyeing agent rather than as a tan. It contains a red colouring matter striking a greenish colour with ferric chloride but giving no precipitate with gelatine. The colouring matter is precipitated by acids and redissolved by alkalies. The ash of the air-dried bark amount to 11.4 per cent. and is deliquescent." Van Katesan (1966) reports 5 percent of tannin in the stems and bark.

Rageau (1957) quotes Verguin (1956) to the effect that "à Madagascar, l'infusion de feuilles est préconisées contre la fièvre jaune", but A. officinalis does not occur in Madagascar — the species there is A. marina.

It is of interest to note that, according to Scopoli (1777), Osbeck gives this description of the fruit of A. officinalis: "Avicenniaee. offic. Fructus nuci similis, nuclei loco fovens succum nigrum."

Paul Chai, Forest Botanist in the Office of the Conservator of Forests, Sarawak, has very kindly sent me some excellent photographs taken by him of specimens of A. officinalis in Sarawak, herewith published with his permission. In letters to me dated September 14, 1971, May 25, 1973, and August 11, 1973, he states that from his own observations in the field A. alba var. latifolia Moldenke has "lenticellate bark surface throughout the main trunk", a feature not exhibited by A. marina or A. officinalis in Sarawak. He also avers that he has "found in Sarawak some individuals of all 3 species (alba, marina and officinalis) [which] possess stilt roots. These individuals were found to be confined to soft muddy soils......Unlike the stilt roots of Rhizophora, stilt roots of Avicennia are more slender and soft. They arise in the same way as aerial roots which extend and reach the mud eventually. A. officinalis which is found on firm soil along river banks further inland produces aerial roots from about the middle of the trunk way above the ground. In this case they seldom reach the ground and eventually dry off and die but those that are formed nearer the ground do reach the soil." He continues: "I agree with you that A. marina cannot be distinguished from A. intermedia."

Janssonius (1926) investigated the microscopic characteristics of both the cross- and tangential sections of the wood of A. officinalis, based on Koorders 12938β, 12944β, 20623β, 20633β, 39760β, & 29800β from Java. The wood anatomy is also discussed by Baker (1916).

Basu (1965) describes cultivation experiments with this species in the Indian Botanic Garden where there was 67 percent seed germination and seedling survival to 7.5 cm. height and the production of 4 leaves per plant.

Manjunath (1948) describes A. officinalis as "a shrub or small tree of the salt marshes and tidal forests of India, Burma, Ceylon, and the Andaman Islands. In the Sunderbans, it grows to a fairly big tree, 40--60' high, with a girth of 12--15'. On the Coromandel coast it is generally a bush. It is also common along the

coasts or Burma. Two or three varieties are differentiated by the colour of the bark, which may be black, white or mottled. The wood is brittle and coarse-grained, and is used only as fuel [in India]. On account of its attractive grain, the wood may find a place in small cabinet work, and is recommended for trial as creosoted paving blocks."

Then he apparently confuses this taxon with A. marina, for he goes on to say "The wood from Tanganyika was found to contain cellulose, 54.7 percent and ash, 2.3 percent of moisture-free wood. In paper-making trials, it was readily pulped by the soda process, on account of the shortness of its fibres. The pulp, however, was not easily bleachable. Besides, the wood chipped badly producing a large proportion of waste.....Wells has examined the tar prepared from the wood.....(1917), and the wood-ash is reported to be rich in alkali......The tannin content of the bark is only 2.5 percent.....with 12 percent of non-tannins. The kernel of the fruit, though bitter, is reported to be edible. The leaves are used as cattle fodder in Australia....The green, bitter and somewhat aromatic resin which oozes from the bark is said to possess medicinal properties." It is not clear just how much of this information applies to the African tree (A. marina), the Australian tree (probably A. marina var. resinifera), or the Indian tree (A. officinalis).

Pételot (1953) provides a very lengthy review of reputed uses of A. officinalis in various parts of the tropics then under French influence, with quotations from local physicians, but in his report there are quotations which most certainly do not apply to A. officinalis, but rather to A. marina, A. marina var. resinifera, A. germinans, and perhaps even other taxa. Among the uses ascribed by him to what may actually be A. officinalis are the following: in Vietnam "L'écorce est ordinairement employée contre les maladies de la peu et principalement contre la gale". In India "les racines possêderaient des propriétés aphrodisiaques et que les graines immatures seraient employées en cataplasme pour faire mûrir les abcès. Il signale également que les cendres du bois seraient employées en guise de savon.....L'écorce d'Avicennia n'a aucune action sur le coeur, elle augmente la diurèse. Quelquefois on rencontre de l'intolérance, l'effet le plus constant est marqué par des nausées et des vomissements. A une dose assez élevée (7 à 8 g. d'extrait mou), it se produit des céphalées opiniâtres et insupportables......Dans son travail, Bocquillon-Limousin [1911] calque les préparations galéniques d'écorce de Palétuvier sur celles d'écorces de quinquina. On peut donc en fabriquer un vin et un extrait mou." He gives two detailed chemical analyses which may apply to this species, but the lengthy description of its use in the treatment of leprosy in Cuba, and its uses in French Guiana, Australia, New Caledonia, Guadeloupe, and Mexico obviously apply to other taxa than this one.

Watt & Breyer-Brandwijk (1962) have also mixed data applying to A. marina with data applying to A. officinalis, but of the informa-

tion which they give and which may well apply to the latter taxon is the following: "The bark which is astringent contains tannin.. is used as [a] dyeing agent in India and in Madras the ash from the wood has been used for washing clothes....The fruit is eaten as an ordinary article of diet by the fishermen of Java and the Celebes....but....in the Celebes the fruit is a famine food, being soaked in water for a fortnight and then boiled for use. The seed is bitter but edible.....The sapwood yields a resin...which is used in the Philippines as a local application in snake-bite.. and in western Java as a contraceptive.....In India as well as in the Philippines the seed cooked in water is applied as a maturative poultice and as a cicatrizing agent in ulcers....The cortical portion of the wood yields a crystalline substance, identical with lapachol...."

Uphof (1968) also affirms that the astringent bark is used as a tanning material, ashes of the wood are employed for washing and cleaning clothes and mixed by painters with their paints in order to make the paint adhere more firmly, while the wood itself is used for fuel, for making cheap beams and door-frames, the green fruits are used in India as a poultice in the treatment of boils, etc.

It should be noted here that the "A. tomentosa" of Blanco, referred to in the synonymy of A. officinalis, is a synonym of A. marina var. rumphiana (H. Hallier) Bakh., while the homonym of it credited to Blume is a synonym of A. alba Blume, that of Brown and of Sieber (in part) is A. marina var. resinifera (Forst. f.) Bakh., that credited to Jack, to Jacquin, to Linnaeus & Jacquin, to Meyer, to Nuttall, to Nuttall & Brown, to Sieber (in part), to Swartz, and to Weigelt is A. germinans (L.) L., that credited to Linnaeus, to Vahl, and to Wallich is A. marina (Forsk.) Vierh., and that credited to Schauer, to "Jacq. sensu Schau.", to "sensu Marc.", and to "sensu Mayc." is A. schaueriana Stapf & Leechman.

Avicennia tomentosa (mostly credited to Jacquin) is given as a synonym of A. officinalis by Watt (1889), by Trimen (1895), by Baker (1900), by Prain (1903), by Cooke (1906), by Glover (1947), by Parsa (1940), and by Hartwell (1971), but actually only A. tomentosa Roxb. and A. tomentosa Willd. belong in the synonymy of A. officinalis L., although the "E. [sic] tomentosa Roxb." of Mukherjee & Chanda (1973) is probably A. alba Blume. Boissier (1879) regards "A. tomentosa Wall." as a synonym of A. officinalis, but actually it belongs in the synonymy of A. marina (Forsk.) Vierh. Clarke (1885) not only includes A. tomentosa Jacq. in the synonymy of A. officinalis, but also A. resinifera Forst. and Halodendron thouarsii Roem. & Schult. and comments that "Mr. Bentham considers the American and African A. tomentosa not specifically separable" — thus apparently adding A. germinans (L.) L. and A. africana P. Beauv. to its synonymy, a completely untenable disposition.

Griffith (1854) keeps A. tomentosa Jacq. as distinct and places "A. tomentosa Roxb." in the synonymy of what he calls A. obovata W. Griff. [obviously conspecific with the older A. officinalis, for which it was merely a new name]. The "A. tomentosa L." of Don (1830) probably applies to A. marina, but the A. tomentosa of Good (1964) appears actually to refer to A. officinalis L.

Baker (1900) gives the extralimital distribution of what he calls A. officinalis as "Also in Egypt, Natal, and the tropical shores of both hemispheres" — again, an obvious mixture of the distributions of several taxa, since A. officinalis does not occur either in Africa nor in the Western Hemisphere.

Schubert (1969) notes that, under the present International Code, Bontia germinans L., Syst. Nat., ed. 10, 2: 1122 (1759) "was nomenclaturally superfluous when published since it included Avicennia officinalis Linn. 1753 (the Asiatic mangrove). However, according to Art. 63, Note, since the American mangrove is considered to be specifically different from the Asiatic, the name A. germinans is the correct name [for the American portion of the material included in Bontia germinans]."

It should also be noted here that the "Avicennia officinalis L." of Harvey (1868), of Baker (1900), of Almagia (1903), of Dunn & Tutcher (1912), of Parthasarathy (1927), of Sasaki (1928), of Wangerin & Krause (1941), of Glover (1947), of Verguin (1952), of Montasir & Hassib (1956), of Watt & Breyer-Brandwijk (1962), of Khattab & El-Hadidi (1971), of Weiss (1972), and of Por (1973) actually is A. marina (Forsk.) Vierh., while that of Ostenfeld (1918), of Cockayne (1921), of Wangerin (1923, 1926, 1935), of Laing & Blackwell (1927), and of Rageau (1957) is A. marina var. resinifera (Forst. f.) Bakh. and that of Khan (1961) is A. marina var. acutissima Stapf & Moldenke.

Parsa (1949) includes "A. resinifera Forst." and Halodendron thouarsii Roem. & Schult. in the synonymy of A. officinalis L. Burman (1768) erroneously regarded Oepata Rheede as a synonym of the American Avicennia germinans (L.) L. Melchior (1946), DeWit (1967), and Amico & Bavazzano (1968) mistakenly reduce A. officinalis L. to the synonymy of A. marina, while Corner & Watanabe (1969) take the equally erroneous opposite course and reduce A. marina to the synonymy of A. officinalis! Both dispositions are palpable incorrect — the two taxa are separate, distinct, and valid species!

Hallier (1918) adopts the name, "Avicennia oepata Ham.", for A. officinalis L. and includes as synonyms A. officinalis L., A. tomentosa Lam., A. obovata Griff., "Avicennia L., Fl. Zeyl. 23. 1748", Bontia germinans L., and Oepata Rheede. Burkill (1966) places what he calls the "A. officinalis, of many authors" in the synonymy of A. lanata Ridl.

Crevost & Pételot (1934) actually include A. alba Blume, A.

africana P. Beauv., A. floridana Raf., A. elliptica Thunb., A. lamarckiana Presl, A. meyeri Miq., A. oblongifolia Nutt., A. tomentosa Jacq., and A. resinifera Forst. in the synonymy of A. officinalis L.! Of these, 3 are themselves valid species, one is a variety of A. marina, and the other 5 are synonyms of A. germinans. The reputed medicinal uses listed by these authors is similarly a hodgepodge of data applying to various of these taxa.

Kuntze (1891) divided A. officinalis into varieties as follows:

α nitida (with "A. africana Beauv. non Schauer" as a synonym), with "Folia anguste lanceolata (1: 4—8) rarius obtusiuscula", from St. Thomas (West Indies);

β lanceolata, with "Folia late lanceolata (1: ±3)", from Trinidad and "Auch in den anderen Erdtheilen innerhalb des heissen Zone nicht selten";

γ ovatifolia, with "Folia ovata acuta obtusiuscula (1: ±2)" from Cochinchina and Java;

δ spathulata, with "Folia ovata (1: ± 2) apice rotundata vel retusa basi attenuati";

δ spathulata f. tomentosa, with "Pubescentia pulerulenta [=puberulenta? pulverulenta?] densior subvelutina" from Singapore (with "Avic. tom. auct. pl. vix L. ex Jacq. l.c. [am. t. 112] f. 2 foliis 'cordato' ovatis");

δ spathulata f. glandulosa, with "Folia glabra glandulis pellucidis crebris punctiformibus munita. Calyx cum bracteis viscosis" from Java.

Of these, I regard var. nitida as A. germinans (L.) L., A. africana P. Beauv. as valid, var. lanceolata as A. germinans var. guayaquilensis (H.B.K.) Moldenke, var. ovatifolia as A. marina (Forsk.) Vierh., var. spathulata and its f. tomentosa as A. lanata Ridl., and var. spathulata f. glandulosa as possibly A. marina var. resinifera (Forst. f.) Bakh. or true A. officinalis L. (more probably). Kuntze reduces "A. officinalis 'S. Kurz' Fl. Burma non L.", "A. alba Miq.", and "A. officinalis var. alba Clarke" to synonymy under what he calls A. spicata Kuntze (and which I regard as the true A. alba Blume).

It should also be noted here that as yet I have not been able to see copies of the two additional illustrations listed for A. officinalis on a previous page of this paper, and feel that probably they will be found to represent, not A. officinalis, but A. marina instead.

The Chai S.30643 collection, cited below, is accompanied by wood samples in at least some herbaria; Collector undetermined s.n. [Panadura, Oct. 27, 1881] and G. Gardner s.n. [Thwaites C.P.1961] are mixtures of A. officinalis L. and A. marina (Forsk.) Vierh. The Neth. Ind. For. Serv. bb.24925, cited below, is placed here doubtfully.

Some material of A. officinalis has been misidentified and dis-

tributed in herbaria as A. marina (Forsk.) Vierh. or as A. marina var. resinifera (Forst. f.) Bakh. On the other hand, the Falconer 241 and J. Schmidt 141, distributed as A. officinalis, actually are A. alba Blume, H. M. Curran 240 & 252 and L. H. MacDaniels 2010 (in part) are A. germinans (L.) L. or one of its varieties, Schimpff 30 is probably A. germinans var. guayaquilensis (H.B.K.) Moldenke, Backer s.n. [3-XII] & s.n. [Batavia], H. H. Bartlett 13706, Forster 117, Hildebrandt 3234, Holst 3059, Kurz 107 & s.n. [South Andamans], Loher 4450, Meebold 12828, Pappi 3168, Prain's Collector 74, Schimper s.n., Schlieben 5787, G. Schweinfurth 966, Sieber Fl. Nov. Holl. 268, Surapat 358, and Tirvengadum & Waas 465 are A. marina (Forsk.) Vierh., Baas Becking 6185, Balansa 1337, J. H. Davis s.n. [May 1950], Doore & Earle 276, MacDaniels 2010 (in part) & 2504, McKee 2114 & 3153, Meebold 3402, 5233, & 7304, F. Mueller s.n. [Northern part of York Peninsula], Vieillard 1050, and K. Wood s.n. [22-6-52] are A. marina var. resinifera (Forst. f.) Bakh., and Chai 4 & PC.3 and Fosberg 43820 are A. marina var. rumphiana (H. Hallier) Bakh.

Additional citations: INDIA: Kerala: Collector undetermined 2599/1837 (Pd); Manilal 9 (Ac). SRI LANKA: Collector undetermined s.n. [Panadura, Oct. 27, 1881] (Pd); Davidse & Sumithraarachchi 8978 (Ld); G. Gardner s.n. [Thwaites C.P.1961, in part] (Pd); Jayasuriya 1356 (Ld, N, W—2765419); Macnae s.n. (W—2680242); Moldenke, Moldenke, & Jayasuriya 28249 (Ac, E, Gz, Kh, Ld, Pd, Tu); Tirvengadum, Cramer, & Balasubramium 245 (W—2764111); Worthington 529 (Pd). BURMA: Tenasserim: Falconer 383 (Pd), 388 (Pd). MALAYA: Penang: Wallich 1742/1 (Pd). Selangor: Kasi bin Rajab 103 (Kl—1103, Kl), 4631 (Kl—4631); Khoo & Ming N.K.068 (Kl—8637); B. C. Stone 5930 (Kl—5616). Singapore: A. M. Gill 20 (Ac, Ba, Ft—9688), 21 (Ft—9692, Z); F. R. Fosberg 36953 (W—2584970a). GREATER SUNDA ISLANDS: Java: Koorders 20698β (Pd). Sarawak: Chai S.29942 (Ac), S.30643 (Ld); Chai & al. S. 26712 (Ld). MOLUCCA ISLANDS: Weda: Neth. Ind. For. Serv. bb. 24925 (N). NEW GUINEA: Papua: Darbyshire 784 (Ba); Womersley NGF.46469 (Mu). NEW GUINEAN ISLANDS: Daru: Streitmann & Lelean 18468 (Mu). AUSTRALIA: New South Wales: A. M. Gill s.n. [7 April 1970] (Ba).

[to be continued]

BOOK REVIEWS

Alma L. Moldenke

"BIOGEOGRAPHY: An Ecological and Evolutionary Approach" 2nd Edition by C. Barry Cox, Ian N. Healey & Peter D. Moore, ix & 194 pp., illus., Halsted Press of John Wiley & Sons, Inc., New York, N. Y. 10016. 1976. $9.95 paperbound.

I sincerely hope that this heavily enriched and up-dated edition of the fine first edition of 1973 is made accessible to increasing numbers of students, especially in the U. S. A. The additional material includes "the relationship between biogeography and continental drift,.....results of recent work in such fields as biological control, ecosystems and plant productivity." Any potential readers or students who are not yet familiar with Warson's studies in grouse population regulations and the many possible concomitant extrapolations will find these matters fully discussed in this work.

Here is a fortunate instance of "more and better" book at no price increase!

"HANDY MATRICES OF UNIT CONVERSION FACTORS FOR BIOLOGY AND MECHANICS" by C. J. Pennycuick, 47 pp., Halsted Press of John Wiley & Sons, Inc., New York, N. Y. 10016. 1976. $2.95 paperback.

This book comes to the U. S. as a 2-year old import from Great Britain. It is a great help in bridging the gap between assorted measurements or units that appear in the earlier literature, in different areas, in the gravitational or technical dimensions used by mechanical and aeronautical engineers and in the many variants of the metric system that differ from the now formally adopted, truly metric Systême Internationale (S I).

For each type of quantity a selected set of units usable in some branch of science, an appropriate factor for conversion into any other has been carefully calculated. Each factor is expressed in a scaled form of a 5-digit number followed by the power of 10 by which it is multiplied. Thus an appropriate conversion factor is immediately available for use with pocket, desk and other calculators of miniaturized electronic circuitry.

When I inquired among friends as to the accuracy of the computations and of the figures printed in this book I received only favorable reports.

"ALGAL CULTURES AND PHYTOPLANKTON ECOLOGY" by Gordon Elliott Fogg, 2nd Edition, xv & 176 pp., illus., University of Wisconsin Press, Madison, Wisconsin 53701. 1975. $12.50.

This edition appears a decade later with more recent information on the behavior of phytoplankton in a wider range of its natural habitats and lab cultures. The same chapters are maintained but much of the text has been rewritten with fine new illustrations, charts and bibliography.

The Preface to the Second Edition replaces the first one and includes this orientation that "there has been a growing realization that such knowledge is of great value if effective and ecologically acceptable ways of dealing with pollution and of using aquatic environments as sources of food are to be devised."

A fine and useful book!

"A DICTIONARY OF GENETICS" by Robert C. King, 2nd Edition, iii & 337 pp., illus., Oxford University Press, London, Toronto, & New York, N. Y. 10016. 1972. $5.95 paperbound.

Four years after the appearance of the first popular edition this one has appeared, incorporating 700 new entries as appropriate changes that reflect the continued spectacular growth in this field. The additions to the appendices on chronology, journals on a worldwide basis, and teaching aids are particularly helpful to students and/or instructors in areas away from large academic centers.

The lilac genus and a few other words are misspelled.

It is interesting to note that <u>Drosophila melanogaster</u> is placed in the 7th subgenus <u>Sophophora</u> instead of the 8th <u>Drosophila</u> and that the terms taxonomy and systematics are considered to be synonymous.

The author of this book is well known for his widely used text on "Genetics", also a publication from the Oxford University Press.

"A PRIMER OF POPULATION BIOLOGY" by Edward O. Wilson & William H. Bossert, 192 pp., illus., Sinauer Associates, Inc., Publishers, Stamford, Connecticut 06905. 1971. $3.95 paperback.

The success of this presentation is built upon the very considerable scientific and teaching skills and thinking of the two well-known Harvard University centered authors. The original draft was subjected to rigorous appraisal after independent and class study at Harvard University and Cornell University.

Since it is designed to be self-teaching, it can and has achieved this goal with many readers who learn how to study this topic from (1) a necessary quantitative approach through painless and accurate construction of a mathematical model, (2) an analy-

sis of population genetics and its evolutionary forces and effects through changes in gene frequency, (3) the population basis of ecology, and (4) the species equilibrium theory and its interpretation of biogeography. Remember that the senior author and Mac Arthur published that excellent work on "The Theory of Island Biogeography" in 1967.

The problems are intriguing and their solutions are helpfully given.

"BIOLOGY OF PLANTS" by Peter H. Raven, Ray F. Evert & Helena Curtis, 2nd Edition, xv & 685 pp., illus., Worth Publishers, Inc., New York, N. Y. 10016. 1976. $15.95.

Why all the dozens of less-than-even-mediocre botany texts continue to be ordered through so many academic institutions when there are less than a half dozen of really outstanding choices like this one and its earlier excellent edition of 1970 is hard to fathom. The same predicament exists for general biology, zoology, ecology (especially) and probably in other fields of instruction.

This new edition of "Biology of Plants" has a third author's name added because Ray Evert used the first edition as a teaching text "and had excellent ideas for making it better...., [incorporating] the major advances in our understanding of virtually every discipline of plant biology....,[continuing to emphasize] the interrelationships of evolution, diversity, and ecology,.....[and presenting] each section of the book as independent as possible, so that topics do not have to be presented in lockstep with our preferred sequence."

This text is richly, not garrishly, augmented with even more excellent drawings, diagrams, natural colored slide prints, and electron microscopy prints that are all pertinent.

It seems to be "out of fashion" now to encourage students to start or continue to build good personal and professional libraries. This text (and its predecessor) are highly recommended for that purpose. In keeping with this trend many young professors (who should really know better) do not require students to have at least one comprehensive excellent text for their subject.

The generic name of the barrel cactus is misspelled in both editions. The specific name of the American black mangrove is now <u>Avicennia germinans</u> (not <u>A. nitida</u>).

In both editions the same labeled typhus-vector diagrams are used, but which do not indicate by arrow or newer scientific names the different roles, shapes, etc. of head, body ("cooties") and pubic lice in humans. This is figurative and almost literal "nit picking" preparatory to the anticipated 3rd edition a few years hence.

The basic biologic adaptations explained in these three connections are of much greater positive importance than these neg-

ative "nits".

"TROPICAL FOREST ECOSYSTEMS IN AFRICA AND SOUTH AMERICA: A COMPARATIVE REVIEW" edited by Betty J. Meggers, Edward S. Ayensu & W. Donald Duckworth, viii & 350 pp., illus., Smithsonian Institution Press, Washington, D. C. 20560, distributed in U.S.A. & Canada by George Brazillar, Inc., New York, N. Y. 10016, elsewhere by Feffer & Simons, Inc., London WIN 3LE. $15.00 hardcover, $5.95 paperbound. 1973.

This decidedly worthwhile publication is the remnant-substitute for the 4th International Symposium of the Association for Tropical Biology hopefully to have been held in Ghana, West Africa, in 1971, but cancelled because sufficient funds were lacking (even for fully indexing this valuable material?).

The lowland tropical forest ecosystems of Africa and South America, particularly Amazonia, are in grave danger from "development" programs with the ecosystems' threatened destruction along with concomitant loss of yet unknown scientific information. The editors* and authors* "hope that this volume will have some impact on those** with power to influence the character of future human intervention.....because even now we know enough to avoid calamitous mistakes."

The book consists of 26 interestingly written and well documented papers by known scientists* who for all their specialized fields of research seem to conclude with Dean Amadon that "the tropical rain forest is paradoxically the most vigorous and yet one of the most fragile of terrestrial habitats. Destroy the forest, as is being done at such a calamitous rate, and the soil is soon washed away by the torrential downpours. These forests, aside from their esthetic and scientific values, should be cherished as biological storehouses, the source of new plants, new drugs, new boons for mankind. Exploit them ruthlessly as at present, and the next generation will reap a whirlwind."

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* These folks understand the problems, but usually do not make the direct important decisions.

** These folks may or may not understand the problems, but may be "profit" or otherwise motivated.

"AUSTRALIAN BUTTERFLIES IN COLOUR", text by Alexander Burns, photography by E. R. Rotherham, 112 pp., illus., A. H. & A. W. Reed of Sydney, Melbourne, Wellington & Auckland. 1969. U.S.A. distribution by Charles E. Tuttle, Inc., Rutland, Vermont 05701. 1973. $8.95.

This lovely, skillfully and accurately prepared book is a thing of beauty that should catch and hold the interest of those

who love color, form and motion as exemplified by these creatures, those of all ages fascinated by insects and especially by "leps", those who visit "down under" and want a pleasant worthwhile souvenir of their travels for themselves or friends at a very reasonable price. It is really a convenience for those in or near the U.S.A. to be able to have a copy of this book before or after a trip without adding it to luggage to be toted about.

For 85 Australian species, text describing interestingly their habitats, habits, and food plants is given succinctly on the left-hand pages, while on the right-hand side are the excellent printings of the beautiful color photographs of the male and female, showing both the upper and the undersides of the wings if these are differently colored or patterned. The specimens are in excellent condition; consequently there are no tipped hairs or threads substituted for knobbed antennae and there are no pinholed thoraxes. A small part of each color plate has a section showing in a darker blue the geographic distribution of each species as it occurs on the continent.

The first Australian butterflies were collected by Sir Joseph Banks and were named and described by Fabricius in 1775.

"KRYPTOGAMEN: Blaualgen, Algen, Pilze, Flechten - Praktikum und Lehrbuch" by Karl Esser, xvi & 572 pp., illus., Springer-Verlag, Berlin D-1000-33, Heidelberg & New York 10010. 1976. DM 58.00 or $23.80 flexible cloth-cover.

Oh, for a magic wand that could be so wafted as to besiege all text-ordering committees in biology and botany in our advanced public and private secondary schools and in our colleges and universities with requests for copies of "KRYPTOGAMEN"!

The magic wand would not offer just advertising circulars or unearned free copies because either or both might be disregarded and/or undervalued. Not being able to read the succinct German language accompanying text is not important either. But the exquisitely accurate, detailed, carefully labeled figures are of very great value, buoyantly stressing the beauty of design, structure, function in much the same way as Leonardo da Vinci's human anatomy drawings do. The more than 300 illustrations of many parts themselves include drawings, life-cycle diagrams, SEM and optical microscope photographs also labeled and measured with extraordinary precision by American text standards now.

The use of scientific names as an international advantage should become apparent as well as the marked similarity of the labels. Who could have trouble translating "Konidiosporen"? Even the text taken in small doses, associated with the illustrations, often becomes quite understandable.

Oh, for that magic wand to check our needlessly inept drawings in texts, workbooks and lab manuals!

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ON THE ECOLOGY OF THE SAPROLEGNIACEAE

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The aquatic environment has been examined throughout the world by numerous investigators for the identification of isolated fungal species. Journal literature holds many reports in taxonomy, morphology, anatomy, genetics, nutritional requirements, and related studies on the fresh water fungi, however, much less attention has been directed to the environment of the fungi in terms of microbial ecology. An attempt is made here to view the environment of the filamentous species with emphasis on definitions of microbial ecology.

General Description of the Saprolegniaceae: The Saprolegniaceae is the largest family in the order Saprolegniales. The terms 'water mold' and 'fish mold' are ordinarily referred to the members of this family. Although the designation 'water mold' suggests that the Saprolegniaceae occur exclusively in water, investigations have shown other habitats. Numerous species have been isolated from the soil. They are widely distributed and are among the most ubiquitous of aquatic fungi.

The mycelium of Saprolegniaceae is a variably and profusely branched system of tubular, nonconstrictional coenocytic hyphae, easily visible as it forms a colony around some bit of decaying organic matter, either animal or plant, in water. Structurally, the hyphal walls are composed mainly of cellulose. No septa are formed except in the mycelium just below the reproductive organs and in the delimitation of gemmae (chlamydospores).

Asexual reproduction is effected by zoospores in zoosporangia which are typically long, cylindrical, and terminal. Zoospores generally mature prior to the formation of the sexual reproductive organs. Sporangial proliferation is an interesting phenomenon characteristic with the representative genera. It may occur in various ways. In the genus Saprolegnia it takes place as follows. When a sporangium has emptied its contents of spores, another or secondary sporangium is often initiated at the basal septum, and grows through the first sporangium, maturing within the other, each maturing and shedding its spores before the next one is formed. As a general rule, the sporangia of the Saprolegniaceae remain attached to the somatic hyphae throughout their lives. The genus Dictyuchus is an exception, the sporangia commonly fall off the hyphae at maturity.

Zoospores in the Saprolegniaceae are biflagellate. Two zoospore types occur in this family. One is the primary zoospore which is pear-shaped with the flagella at the apex. The other is

the secondary kidney-shaped zoospore with two oppositely directed flagella at the concave side.

Diplanetism is the successive formation by a single fungus of 2 different types of zoospores, whereas monoplanetism has only one swarming period and only the primary type of zoospore. In addition, the form of sporangial proliferation and the behavior of zoospores are of great diagnostic importance in distinguishing genera.

Sexual reproduction is accomplished by the formation of oogonia and antheridia. One or several uninucleate eggs (oospheres) are formed in each oogonium which is usually a terminal structure on a hypha. The antheridia are elongated and multinucleate. Four types of antheridia characterized by their point of origin may be distinguished in this family (Ivankow, 1971 and Seymour, 1970).

Fertilization takes place through gametangial contact, the passage of the male gametes into the female gametangium through a fertilization tube. Fertilized oospheres develop into thick-walled oospores. In the mature oospores the fatty reserve is stored in the form of oil droplets characteristically arranged in different species. These arrangements are of considerable taxonomic value. After a period of rest the oospore germinates to produce a tube which gives rise to a zoosporangium typical of the species.

Both homothallous and heterothallous species can be found in the family. Raper (1936, 1949) demonstrated conclusively that at least four distinct hormones are involved in the initiation of sexual organs when potentially male and female thalli grow in close proximity.

Composition of the Community: Constituents of a community are the organisms inhabiting a given site. Members of the Saprolegniaceae are found in most bodies of fresh water. The genera belonging to the Saprolegniaceae have been identified in taxonomic reviews by Coker (1923) and Ainsworth, et al. (1973). A minimum of 10 genera belong to the family, however, more representatives may be found in the literature depending on the reference. Some species are in question due to similarities in established organisms.

In regards to the dominant species of the community, Achlya and Saprolegnia are the two genera which exhibit large populations in water, and they are also predominant on the special host habitat of fish. Tiffney and Wolf (1937) reported in observations from a fish parasite study that Saprolegnia parasitica is the primary parasitic form. At times A. flagellata becomes parasitic and causes severe losses of fish.

Interaction Between Organism and Environment: Environmental factors such as temperature, light intensity, O_2 tension, water level and quality, and substrate are all important to the development of the community composition. In the various papers of Suzuki

(1960a-d, 1961a-f, 1960 w/T. Hatakeyama), it is evident that under field conditions, temperature has a profound effect upon zoospore formation; instances of lowered zoospore production due to unfavorable temperatures are cited. It has been noted that no water molds have been isolated from thermal springs (Cooney and Emerson, 1964). Zoospores are the most efficient unit in establishing and distributing the organisms of the family Saprolegniaceae. Absence of the zoospores of species in an ecosystem usually correlate to the populations in the community. Seasonal occurrence of species is regarded as an environmental selection due primarily to changes in temperature. In spring most species grow well, only a few species can be collected in other seasons (Coker, 1923).

Oxygen is a very important requirement for growth and development for the majority of members belonging to this family. The variation in the correlation of fungi with the oxygen dissolved in the water layers has been reported (Suzuki, 1961a). Achlya flagellata, A. racemosa, Dictyuchus sp., Aphanomyces sp., and Saprolegnia sp. were obtained when the bottom layer of water contained oxygen. Laboratory studies by Suzuki confirmed these results. He reported that the bottom of a lake of the Nikko volcanic group was characterized by jet black reduced mud "resulting in the removal of oxygen from the contacting water" (Suzuki, 1961e). Here aquatic Phycomycetes were very scarce, and Pythium sp. was the only isolate from such a habitat. In anaerobic layers of a lake bottom, Aphanomyces was the only fungus of the Saprolegniaceae found in this extreme condition. The diurnal migration of the zoospores distribution is also considered to be influenced by O_2 (Suzuki, 1961b). An increase in O_2 level will increase the zoospore population.

Water or moisture and nutritional factors also influence species selection. Extremely dry conditions will kill all of the zoospores as well as the hyphal filaments. Low pH and high mineral content deplete saprolegniaceous fungi in various habitats.

The inhabitants in turn modify the composition of their surroundings. Metabolites of the existing members of the community will influence the chemical composition of their surroundings. Some groups are favored by environmental changes and assume greater prominence, while others are not able to cope with the new circumstances. Population density and composition of the community are thus affected. In laboratory conditions, some saprolegniaceous fungi produce metabolites which are toxic to the same fungal species thus inhibiting growth.

Species Diversity: Species diversity clearly varies from ecosystem to ecosystem. It is reported that small populations and great species diversity seem to be associated with nutrient deficiencies. When there is an inflow of nutrients, species diversity frequently declines, for a nutrient-rich area is poor in microorganisms (Harvey, 1942). Zoospores of the Saprolegniaceae may easily be injured or killed if the total osmotic concentration of the

medium is high.

Other conditions such as seasonal effects are responsible for fluctuation in the intensity of an ecological variable. Suzuki (1961a) reported that Saprolegnia monoica, Achlya racemosa, and A. flagellata were found flourishing in winter whereas S. diclina was found throughout various seasons. It was found that Saprolegnia and Achlya occur below the sewage effluent in a stream, whereas species of Aphanomyces were restricted to the cleaner portions of the stream above the entrance to the effluent (Reischer, 1951). Environmental factors previously described would certainly influence the presence of species in an ecosystem as well as the density of existing species.

Habitat: Because the Saprolegniaceae is ubiquitous in distribution, representative species have been found in nearly every aquatic habitat previously investigated such as ponds, streams, stagnant pools, aquaria, sinkholes and the like. Roberts (1963) in a study of Saprolegniales from 21 natural waters in the United Kingdom found that typically more species were collected from the bottom than from surface waters. However, Suzuki (1961f) noted that during the stagnation period in lakes, aquatic fungi were scarce on the bottom. Some vascular plants, fish, and fungi provide habitats for the parasitic Saprolegniaceae. The composition of these habitats is relatively uniform. However, habitats change with food or organic material intake by the animal. The species composition of the residing organisms are thus affected. Some pink salmon in rivers have recovered from disease induced by Saprolegnia when the salmon were transported to marine water (Ivankow, 1971).

Dispersal: Dispersal is essential for the continued existence of many species. This is particularly true for parasites that are capable of independent existence in vitro, yet they are restricted in nature to life in association with a suitable host. In such instances individuals of the species must escape from the locally detrimental environment and find a new habitat conducive to the continued existence of the species. The lack of means of dissemination could mean the elimination of the species.

Dissemination may occur by virtue of active movement or growth, or it may result solely from the passive transport of the microorganism by means not under its own control. On the other hand, if the microorganisms are not able to escape in space from unfavorable locales, they have a mechanism for an escape in time: a structure allowing the species to endure adversity such as oospores or gemmae.

Unit of Dispersal: Zoospores are typically produced as an asexual means of reproduction in species of Saprolegniaceae. Two types of zoospores occur, i.e., primary zoospores which are pear-shaped, and secondary zoospores of a kidney shape. The behavior of the zoospores varies in different genera and thus serves as an important taxonomic character. The typical manner and activity of zoospore liberation from zoosporangia, variation in the discharge

and behavior of the spores are well described by Coker (1923). He concluded that the variations are the results of environmental conditions.

Under normal environmental conditions, the zoospores of Achlya encyst immediately after emergence at the mouth of the sporangium in the form of a hollow sphere. The zoospores undergo a second motility period which is followed by encystment and germination. This zoospore development and germination sequence is fairly constant, although under varying culture influences minor changes have been reported (Collins, 1920 and Lechmere, 1911). If the concentration of specific nutrient present is above a certain threshold, the encysted spores germinate by a small tube which eventually forms mycelium but if the quality of nutrient material is below this value, then the encysted zoospore emits an active laterally biflagellated spore for a third motility period. Three, four or five motility periods can occur with each zoospore with environmental manipulation.

"Selective power" of fungal zoospores for suitable substrates was studied. In Achlya (Salvin, 1940), if a zoospore on emerging from the encysted condition is unable to find a suitable substrate, it can pass again into a resting state, and then once more emerge as an active entity until it finally finds a favorable substratum to locate and start a new colony. This kind of phenomenon was also observed in Dictyuchus (Weston, 1919). This rejuvenscence of motile cells is dependent upon stored energy, and also on reserve food material. Weston also found that Thraustotheca clavata was unable to form the repeated emergence of zoospores under similar conditions. It appears that some inherent factor may control this phenomenon.

Chemotactism was long ago shown to be characteristic of aquatic Phycomycete zoospores. Fischer and Werner (1958a,b, 1955) found that chemotactic sensitivity of saprolegnian zoospores was largely dependent upon their age and solutes in the medium. Alkaline metal chlorides and alkaline earth metal chloride such as $CaCl_2$ and $MgCl_2$ are positively chemotactic substances. Protein freed of the dialyzable fractions had no tactic effect. Very small amounts of different amino acids function to increase the chemotactic activity of the aforementioned salts. Solutions containing primarily NaCl and KCl and traces of amino acid mixtures induce both the chemotactic attraction of zoospores to natural substrate and their subsequent encystment.

Other environmental factors, such as temperature and oxygen tension also play an important role in determining the success of zoospore liberation. Turbidity of the water was found to affect the spore dispersal (Petersen, 1910). When silt is in suspension in water, zoospores are prevented from reaching a proper substratum.

Gemma or chlamydospore is another kind of propagule found under environmental stress, such as dry conditions and high temperatures.

Certain parts of the hyphae give rise to gemmae. Upon the advent of favorable conditions, the gemmae germinate to produce either hyphae or short stalked zoosporangia. At 27°C, Saprolegnia ferax produced only gemmae, whereas sexual organs were not formed. Efficiency of dispersal is operated by three factors in the fresh water fungi. Repeated formation of motile cells occurs until a hospitable environment is reached. Formation of resistant propagules or gemmae assist in species survival. The release of a vast number of spores increases the chances of locating a suitable substratum for the organism.

Colonization: Changes in species composition of ecosystems invaded or inhabited by microorganisms are seen in numerous places. The innoculation of a medium initiates a dramatic sequence of changes in the types of organisms present. This kind of change in response to the modification of environment results from a successful colonization.

Colonization and the Pioneer: The development of a colony of mycelium of Saprolegniaceae in a natural habitat is usually initiated by zoospores. Germination of zoospores begins when a suitable substratum is invaded. Growth and development of hyphae are followed by the formation of a colony or colonies.

If the substratum is initially devoid of saprolegniaceous fungi, a succession is initiated by the first invaded species, the pioneer species. In general, the pioneers have a transitory existence and are rapidly eliminated. As they grow, they influence their surroundings by secreting or producing some substances which are toxic or unsuitable for themselves. Later species arrive as the surroundings are modified. Some species of Saprolegniaceae in laboratory storage need an early or frequent transfer of cultures due to the availability of nutrients and water.

Factors Favorable to Colonization: The substratum character and availability are influencing factors for colonization of heterophilic organisms. Submerged twigs, floating fruits, dead insects, dead vertebrates and invertebrates, and other organic debris have been found covered with saprolegnian mycelium in ordinary aquatic habitats. These nutritional preferences appear in nature but may not be so evident under laboratory conditions. The growth requirements of nitrogen, sulfur, and carbon are available from many amino acids and carbohydrates. Both O_2 and moisture are critical factors for zoospore dispersal. An efficient means of zoospore dispersal undoubtedly favors colonization if the substratum is not in question. Other physical factors such as temperature, pH value, etc. also influence colonization.

In parasites, suitable hosts and mechanical characters of the host are important for the initiation of an infection. Wounds on the bodies of hosts such as fish are required factors for the

parasites (primarily Achlya and Saprolegnia) to have a successful infection. Saprolegnia sp., Achlya bisexualis, and A. flagellata have been placed in the category of wound parasites (Tiffney and Wolf, 1937 and Vishniac and Nigrelli, 1957). Artificial factors such as a direct innoculum to a proper substratum would result in growth of the fungal species. For example, hyphal colonies rapidly develop on corn meal agar.

Under natural conditions, hyphal colonies of Saprolegnia and Achlya are frequently found in pure culture. The hyphae grow in a radiate form spreading from a central point. Mycelium of one colony is usually found with similar characteristics for they usually are the same species. Such findings may explain the fact that already well established colonies produce chemical substances that inhibit the growth of other microorganisms. The removal of nutrients necessary to other forms and the simple fact of taking up space by one species limits the introduction of other species into a community. Achlya flagellata found as a parasite was the only species isolated from the water inhabited by diseased trout (Sorenson, 1964). The established community is among the most effective barriers against invasion by new arrivals.

The absence of carbonaceous nutrients in habitats, anaerobic conditions, extreme drought, low pH, extreme high temperature, etc. are physical environmental conditions that are beyond the tolerance range inhibiting the growth and development of a species in a community. Chemical barriers in hosts may be present. The mechanism and reason of some hosts immunity to the parasites are not known. The immunity of fingerlings of brown trout and rainbow trout to Achlya flagellata (Tiffney and Wolf, 1937), however, might be due to a chemical barrier of an unknown substance or substances present in fingerlings. Adult fish, however, are susceptable to the fungus.

Mechanical barriers establishing environmental resistance can be found in fish hosts. It is reported that wounded fish are invaded by Achlya and Saprolegnia (Sorenson, 1964, Sparrow, 1960). The skin of fish serves as an excellent mechanical barrier for the colonization of parasites. The gill region also serves as a suitable invasion area for representative species of the genera.

Environmental Feedback: An environmental feedback is a modification of the habitat resulting from the presence of one or more microbial populations. The change can affect the size, activity, or survival of the invading population or of one or more segments of the community. It is a dynamic component of the environmental resistance of the suscept. The antagonistic action among the saprolegniaceous species and Fungi Imperfecti has been reported. Of the antagonists, 46.9% had inhibitory responding action on Saprolegniaceae. Penicillium rugulosum depressed the growth of all tested organisms (Raper, 1936). The amount of concentration of the antibiotics produced, and the properties of the invader have a profound

influence on the ecological success of an invader. Environmental feedback may also be attributable to the isolation and immune mechanisms of the host.

Succession: Succession is characterized by the shifts both in species in the community and in the relative abundance of the resident species of a community. A successful colonization would initiate a succession. The areas where heterotrophs were previously unable to colonize is usually inhabited by autotrophs such as green algae. As they grow, they influence the surroundings by providing some organic substances which are necessary for the growth of heterotrophs. Then pioneer organisms invade the habitat creating colonization. Once colonized, wave after wave of populations appear and recede. The pioneer community continually modifies its surroundings which are now becoming more suitable for growth of new species. At this situation, succession occurs. The reciprocal interaction between the microbial and non-microbial components of the ecosystem ultimately leads to a form of sterilization. This final microbial assemblage in the area is known as the climax community.

Evidence of succession can be found in laboratory gross cultures. Pond water samples are baited with halved hemp seed. Within a period as short as 48 hours, there may be an explosion of a single species of _Achlya_ or _Saprolegnia_. In time this population is succeeded by another, or several others until activity seems to be at a standstill.

Suitable substratum, abundant oxygen, and temperature are the most influential environmental factors for a successful succession as well as colonization. Petersen (1910) and Lund (1934) emphasized that Phycomycetes are found in calm water since there is little violent wave action, little mechanical damage, and near the shore where oxygen is available in abundance. Constant rolling of substrata by wave action close to shore will no doubt eliminate a substratum of Phycomycetes. The composition of the community is thus indirectly modified. Temperatures and oxygen tension are more or less variable in different depths of water. In warm (22-27°C) surface layers down to 2 meters with an oxygen content of 100-110%, a strong colonization of various bait by _Saprolegnia_, _Achlya_, _Dictyuchus_ and _Aphanomyces_ occurred. Below this depth at 4 meters lies a zone of 15°C water with diminished oxygen content. Here only a moderate degree of colonization of bait occurred and no fungi with _Saprolegnia_-like discharge were recovered. Only _Achlya_-type of discharge occurred at 4 meters.

Seasonal variation of the composition in a community has been studied. The appearance of characteristic species in different seasons is attributable primarily to the fluctuation of temperature. It was found that _Saprolegnia_ spp. were dominant in spring and _Achlya_ spp. in autumn (Hughes, 1962). Barrier and environmental feedback previously described determine the course of a progression. Other factors relating to colonization would, of course, in-

fluence the succession.

The Climax Community: At the climax community the species composition is maintained reasonably constant with the passage of time. Nevertheless the climax may be modified from time to time as the ecosystem is exposed to drastic exogenous forces. Water molds in pools and lakes may be subjected to drought. The climax community in the lower water layers is less influenced by exogenous conditions compared with the surface. Environmental conditions in the bottom area are as a rule more steady which is important for a climax community.

Modification of the climax may be recurrent. The seasonal distribution of Saprolegniaceae is a recurrent process. On the other hand, when the environment becomes irreversibly altered, the climax is deflected and shifts to a steady state. To maintain the climax, energy must be supplied either frequently or continuously. In conclusion, the evidence for the occurrence of ecological succession in Saprolegniaceae has not yet been well recorded and assembled in the literature.

Nutrition: The members of a community obtain their nutritional elements or compounds primarily from their surroundings. From these elements and compounds they synthesize their cellular constituents and obtain energy necessary for their life processes. The nutritional requirements for growth of some species of this family have been investigated and a general picture is beginning to appear (Papavizas and Davey, 1960; Reischer, 1951; Whiffen, 1945). The requirements may be few in number. In general, micronutrients were essential for growth whereas vitamins were not. Glucose seems to be the best source of carbon for most species. Maltose, starch, and glycogen are available to several while fructose, mannose, sucrose and ethanol are utilized by some. Most of the Saprolegniaceae cannot utilize nitrate nitrogen under any condition, but in some investigations it appears that some species are able to utilize ammonium nitrogen as NH_4Cl or NH_4NO_3 under optimum pH range (5.4-6.5) (Sorenson, 1964). In general the Saprolegniaceae grow well on media containing organic nitrogen in the form of peptone or any one of the amino acids. Inorganic requirements include Mg, Ca, Zn, Mn, Fe, and S. Sulfate cannot be utilized, but sulfur can be supplied in organic form as cysteine, cystine, glutathione, methionine, or inorganic sulfide.

Because most fungi are saprobes, they depend on dead organic matter for nutrition. In nature, the greater abundance of individuals in open sunny marshes and ditches is probably due to the large amount of organic substances in such places. In collecting the species, the "baiting" technique has usually been employed. It is widely known that hemp seeds would be the most suitable bait. Hemp seed not only contained sufficient stored food material for growth of saprolegniaceous fungi but the seed also has further advantage in reducing culture contamination, especially bacteria (Harvey, 1925). Hemp seeds are commonly used for the collection, propagation, and main-

tenance of aquatic isolates.

Various isolation techniques were developed by workers (Johnson, 1956 and Raper, 1937). Natural media and synthetic media have been used. Natural media included: corn meal agar, potato dextrose agar, malt agar, yeast extract agar. A medium of glucose glutamate agar (Seymour, 1970) was adopted as a synthetic medium for isolation of Saprolegnia.

Patterns of Nutrition: Most of the members of Saprolegniaceae are saprobes, however, some deviate from these nutritional requirements. A few species are important parasites. Some species of Saprolegnia, i.e., Saprolegnia parasitica, cause disease of fish, fish eggs, and frog eggs. Some Achlya species had been reported as fish parasites. Olpidiopsis is a genus causing diseases to some members of this family. Aphanomyces contains several destructive parasites to the roots of vascular plants.

Undoubtedly, all of the parasitic species obtain their organic nutrients from their hosts. As a general rule, they can be isolated and grown on natural media or on synthetic media containing beef extract, yeast extract, or peptone (Sparrow, 1960). With most fungi, exhaustion of the food supply favored sporulation (Lilly and Barnett, 1951). Klebs (1899) kept a culture of Saprolegnia mizta in the vegetative condition for $2\frac{1}{2}$ years by constant renewal of the nutrient solution. Yet this fungus produced spores within a few days when the food supply became exhausted. Factors affecting the nutritional uptake include enzymes, hydrogen-ion concentration, and other biotic factors in the ecosystem. The limiting factors remain uncertain.

Tolerance Range: Each species grows, reproduces, and survives within a definite range of external conditions which represent its tolerance range or ecological amplitude for critical factors. The environmental factors (abiotic factors) controlling the distribution and growth of the community of Saprolegniaceae include temperature, moisture, light, oxygen, hydrogen-ion concentration (pH), salinity, and other inhabital factors.

Temperature: Of all the various factors operating at a site, temperature obviously is of great importance. It acts directly upon such processes as germination of overwintering structures for vegetative growth, and for induction of asexual reproduction by means of zoospores. In the various papers of Suzuki, it is evident that under field conditions, temperature has a profound effect upon zoospore formation, and instances of lowered zoospore production due to unfavorable temperatures are cited. Temperature also affects zoospore activity (Salvin, 1941). It is indicated that at 10°C primary zoospores swarm abnormally, some of them (in Saprolegnia) encysted almost immediately after emerging from the zoosporangia, others whirled about in narrow spirals, or rotated their anterior ends slowly while the posterior remained stationary. At another extreme of 30°C, primary zoospore activity was also abnormal. The zoospores,

instead of swimming in a relatively straight line, circled, spiraled, twisted, and carried on vigorous vibratory movements. The phenomenon of fusion of two zoospores was found under this high temperature extremity. It was also reported that the encysted spores, whether within or without the sporangium, mostly ceased their motile activity.

In a comparative study of the primary and secondary zoospore rate of Saprolegniaceae, Salvin (1941) reported that the secondary spore typically carried on normal activity over wider extremes of temperature than the primary spore. The optimum temperature of primary and secondary zoospores is 15-25°C and 10-30°C respectively. It was also shown that the secondary zoospore progressed at a more rapid rate than the primary under a given temperature (25°C). The author explained the faster rate may be due to a higher rate of O_2 intake compared with the primary spore.

Numerous investigations of the temperature effect on formation of oogonia and antheridia in this family have been made. Barksdale (1960) reported that the induction of sexual organs, both on single thalli and on paired thalli, is temperature-dependent. Sexual organs were initiated at 15-20°C in many strains of Achlya that were usually sterile at 25°C. Another report from Szaniszlo (1965) indicated that in continuous darkness 21°C was the highest temperature for the formation of oogonia, while temperature range 18-20°C was optimum. Some other temperature ranges (20-30°C) for the oogonial formation were also found (Milanez and DoVal, 1969 and Krause, 1960). The optimum temperature for producing sexual organs of one of the strains of A. ambisexualis lay between 28-30°C.

The effect of temperature upon interthallic sexual reactions was investigated (Barksdale, 1960). At 20°C in most of the paired cultures, oospores were produced, but not at 25°C. One exception was that in A. bisexualis male strain and female strain, temperature as high as 30°C exerted little effect on the nature of the sexual reaction. In conclusion, lower temperature seems to favor the formation of sexual organs in Achlya (Peterson, 1910).

It has been suggested that Achlya grows best in cold water and completes its life cycle, whereas at high temperatures in seasons of bright sunlight, it has difficulty competing with algae and in forming sex organs (Sparrow, 1973). In laboratory conditions, cultures of Saprolegniaceae are always incubated at 18-22°C which would undoubtedly be the optimum growing temperature of these fungi. Powell et al.(1972) reported in their study of Saprolegnia parasitica that excellent growth occurred between 15-30°C. Stock cultures can be preserved at the temperature as low as 5°C in a certain stock medium. The minimum and maximum temperature for growth and asexual spore formation of the species S. mixta has been recorded as: growth, 0-1 to 36-37°C; asexual spores, 1-2 to 32-33°C.

Petersen (1910) thinks that freezing for a short time need not have a deadly effect on the mycelium, but that freezing for a long

time is absolutely destructive. Coker (1923) found that in all but one of the species (Pythiopsis cymosa), a culture allowed to freeze solidly overnight is killed except for the eggs.

Moisture or Water Level Availability: The members of the family Saprolegniaceae are ordinarily referred to by the term 'water mold'. It suggests that water is a very important environmental factor affecting the growth of these fungi, though numerous species have been isolated from soil. When the growth habitat dries, gemmae instead of zoosporangia are produced. No mycelium or gemmae in any species can survive in a rather dry habitat. Experiments revealed that mature eggs may resist drying. Petersen (1910) made efforts to secure cultures from dry materials but failed.

Light: Although light for most fungi growing in water does not seem to be an important factor, laboratory studies show otherwise in some instances. Szanisalo (1965) indicates that light totally or partially inhibited the production of oogonia in Saprolegnia diclina, but did influence the mycelial growth.

In continuous darkness, 21°C was the highest temperature for oogonial formation. Lower light intensity that suppressed oogonia in culture maintained at 20°C was between 17 and 22 ft.c. A repeated 250 ft.c. photoperiod of 10 hours duration each day also caused inhibition, but daily photoperiods of 2 hours did not do so. Blue and green spectral range completely suppressed the formation of oogonia rudiments in S. ferax has been reported (Krause, 1960 and Szanisalo, 1965).

Oxygen: Quite predictably oxygen proved to be a major factor in determining which fungi will grow in water. For a variety of reasons natural habitats vary greatly in the amount of oxygen available. Dissolved oxygen in a lake, for example comes principally from the atmosphere through the exposed surface of water, and from photosynthesis of green plants. Members of the Saprolegniaceae typically require an abundance of oxygen. Most species of water molds are incapable of growing in a culture bottle tightly sealed which contained the ordinary growth media. Growth is rapid when cotton plugs are used instead of the plastic screw caps. Oxygen seems to be one of the limiting factors of these organisms.

The diurnal migration of zoospores (Suzuki and Hatakeyama, 1960) of aquatic fungi in a shallow (50 cm) lake was closely correlated with the distribution of the dissolved oxygen. On a clear day in the morning the zoospores gather at the surface, where oxygen is abundant. As the oxygen concentration increases in the bottom lake area with time, the zoospores move toward the bottom, and they became distributed uniformly from surface to bottom. By 4:00 p.m. most zoospores are at the bottom. During summer and winter the oxygen concentration is most abundant at the surface and middle region of the lake. Zoospores are found in the surface layer throughout the daytime, apparently in an inactive state.

Hydrogen-ion Concentration (pH): A study concerning pH and the distribution of the Saprolegniales was made (Roberts, 1963). It was found that species fell into three groups; acid group in waters with pH below 5.2, alkaline group in waters with pH above 7.8, and a neutral group of species found over a pH range of 5.2-7.8. Lund (1934) pointed out that some species will thrive vegetatively on both acid and alkaline substances, whereas the formation of reproductive organs seems to be conditioned by a specific range of pH. Krause (1960) found oogonia of Saprolegnia ferax formed only in a range of pH 5.2-7.2, while pH 5.8-6.9 was optimal.

Saprolegnia diclina and Aplanes braunii were recovered only from acid lake water (Suzuki and Hatakeyama, 1960). In the lakes of lowest pH (1.9-2.75), Suzuki (1961c) indicated no fungi were found. In the others, which varied from pH 2.9-5.8, one or more species were found. The greatest number of organisms in any one lake was in the lake with a pH of 5.8. However, some investigators felt that pH was not the decisive factor, primarily because many of the fungi which are obtained from acid habitats did well in water at pH 7.2-7.7 (Lund, 1934).

Osmotic or Hydrostatic Pressure: Some of the water molds, as might be expected, seem unable to tolerate high osmotic concentrations, and media containing relatively small amounts of salts and nutrients are certainly advisable for initial isolations. Dilute media also induce more rapid spreading of the filamentous forms, often allowing normal zoospore emergence.

Salinity: The fungi present in such extreme saline aquatic conditions as that provided by the small pool called 'Bad Water' in Death Valley, CA, face rigorous conditions for life. Nonetheless in this pool Traustochytrium pachyderm was discovered (Sparrow, 1973). Hohnk (1973) found that the freshwater Saprolegnia ferax grew and reproduced best in fresh water. A salinity of 3% inhibited sex organ formation, 7% prevented sporangial formation, at 13% there were no gemmae, and at 25% only a few feeble hyphae were developed.

Other Factors: Several other habitat factors might be briefly mentioned. Harvey (1942) has suggested that altitude affects the distribution of water molds belonging to the Saprolegniaceae. In California at 1100 feet he found water samples from aquatic sites to be rich in water molds whereas at increased altitudes such fungi became fewer and fewer. In a lake at 4600 feet, an asexual strain of Aphanomyces was found in abundance (presumably nothing else); in another at 6750 feet only one specimen, an asexual saprolegnian was found, while at several nearby lakes at this same altitude, no members of the group were found. Neither water nor soil samples taken at 6000 feet produced members of the Saprolegniales. Other factors in addition to altitude must have been at work at the above sites. A species of Achlya has been reported from a small lake at the summit of Mauna Kea on the island of Hawaii (Gregory and Wentworth, 1937), at an altitude of 13,000 feet.

Toxic substances arising from the inanimate constituents produced by algae, fungi, and other members of the aquatic community will no doubt be found to be habitat factors of influence in the ecology of water molds.

Geography: It is apparent that members of the Saprolegniaceae are world-wide in distribution. Nevertheless Petersen's extensive investigation of Danish water molds showed that in Denmark Apodachlya is common while Leptomitus was not recorded (Petersen, 1910). In North Carolina, Coker (1923) stated that Leptomitus was very common, while Apodachlya has been found only once. Similarly other representative genera may be absent from one collecting site while one genus is present in abundance. Such occurrences may be local or on a larger geographic scale within the limitations of similar climatic regions.

The range of a species is limited to regions containing the particular substrates it can use and on which it has a selective advantage over other potential colonizers. In Saprolegniaceae, the greater abundance of individuals or species in open sunny marshes and ditches is probably due to the large amount of organic life in such places.

Temperature is a very important determinant in distribution of diverse species, excessive heat or cold serves an effective means of regulating the geographic range of some fungi. Seasonal distributions are considered to be the result of temperature influence. Apparently spring seems to be the most favorable season for growth (Coker, 1923). Suzuki (1960a) followed seasonal changes in aquatic fungi of Senshun-ike pond through a period of one year. Achlya flagellata was found throughout the year, A. racemosa and Apodachlya brachynema were found only in winter. In Denmark, because of the cold climate, the growth of the Saprolegniaceae begins in the spring, and ends in November. But in Coker's studies (1923), no closed season was found in his findings. He also noted that water molds are present when the water is open any day in winter.

Other factors such as salinity and soil type will influence microorganism distribution patterns. One of these ecological factors occasionally appears to be of prime significance in itself, but frequently a combination acting together probably regulates the extent of spread of a particular organism.

The Microenvironment: The microenvironment is a special microcosm, a distinct ecosystem posing a characteristic community made up of populations coexisting and interacting with one another. The mean physical, chemical, and biological composition of the macrohabitat is often far removed from that of the many microenvironments it contains. Sites at points remarkably close to one another may be vastly different in their nutrient condition, moisture status, oxygen content, light intensity, temperature, pH, osmotic pressure, or the kinds and amounts of toxins.

Changing the macroenvironmental factors described previously would directly or indirectly influence the microenvironments. The diurnal migration of the zoospores of water molds was closely correlated to the distribution of the dissolved oxygen in different water levels of the substrate. Members of the Saprolegniaceae require oxygen for their metabolic processes in life. The vertical distribution of water molds have been studied by Suzuki (1961d) and Willoughby (1961). Some of the saprolegnian fungi are collected from the bottom mud, but their occurrence is rare. This localization is explained by the nutritional availability. Fish, frog eggs, and the water mold itself when parasitized by other aquatic fungi may be viewed as a microenvironment. But biodegradation of these organic substances also provides nutrients for the aquatic fungi that in turn add to the decomposition process. The physical or chemical changes in the organs or tissues where these microorganisms locate will certainly influence the growth and distribution of these parasitic fungi.

Natural Selection: From the existing literature, one may find that the Saprolegniaceae rank high among the ubiquitous filamentous water molds. They are found not only in pools, ponds, lakes, rivers, streams, bogs, but also in marginal as well as terrestrial habitats. Soil samples from below the humus layers in deciduous forests, from stream banks, and associated with lichens and various green cryptogams are particularly satisfactory sources of achlyoid fungi (Klebs, 1899). Sand and soil from wooded areas of predominantly coniferous vegetation yield some isolates but not in abundance. Wet soils from the profundal regions of fresh water lakes may bear species of Achlya.

The presence of the species in the above mentioned habitats indicates that the biotic and abiotic factors in the surroundings are suitable for the growth and development of these fungi. The traits underlying fitness of the species to their special surroundings are not well understood. The physical, chemical, and biological stresses are considered to be influential factors.

Interspecific Selection: Factors of interspecific natural selection include nutrition, temperature, light intensity, oxygen tension, osmotic pressure, availability of free water, pH value, toxic substances and biotic factors. Growth rate is often stated to be the ultimate determinant of selection, populations with higher rates of development alledgedly overgrow and displace slow growers. This is evident in the isolation when the culture is contaminated by bacteria. Because the filamentous fungal cultures always grow much faster than bacteria, a pure fungal culture can be obtained by repeated innoculation of the marginal hyphae to a fresh medium. Under strong light intensity, green algae naturally grow and develop vigorously, and thus the components of the heterotrophs in the same community such as the members of the Saprolegniaceae are strongly affected.

Concerning the substrata, many of the bait types used in

collecting the saprophytic members of the Saprolegniaceae provide favorable nutritional sources for the development of bacteria and protozoans. These contaminating organisms bring about such alterations of the environment as to change drastically the morphology of the water fungi with which they become associated. The unsuitability of hemp seed to the growth and development of bacteria might be due to the inability of the bacteria to utilize this substance because of the absence of certain enzymes. Chemical ingredients of hemp seed could also be toxic to the bacteria.

Other abiotic factors such as temperature, osmotic pressure, and pH also strongly affect the interspecific selection. Although most of the members grow well in a mild situation, the extreme environment may favor the development of few species. No fungi have been isolated from thermal spring water according to Cooney and Emerson (1964). In sphagnum bogs, Achlya treleaseana was found to be highly characteristic of such bogs. Saprolegnia ferax grew and reproduced best in fresh water. Saprolegnia monoica var. acidamica was a predominant species and was widely distributed in acidotrophic lakes of a pH 1.9-2.9 (Suzuki, 1960b, 1961c). Water is the universal requirement of this family. The extreme drought condition of the environment would certainly not permit any water mold to survive, and would prevent zoospores from reaching a proper substratum.

Host as a Selective Factor: Parasites have novel physiological qualities which, when the appropriate host is present and the environment permits the expression of these characteristics, an enormous selective advantage occurs. Some species of Saprolegnia such as S. parasitica cause diseases of fish and fish eggs. The genus Aphanomyces, primarily A. euteiches, attacks a number of economically important hosts, while A. parasiticus invades the mycelium sporangia and oogonia of certain other fungi. The biochemical bases for the selective advantage possessed by the parasites are poorly understood. Nevertheless, a profound host-parasite relationship exists.

Adaptation: Microorganisms respond in different ways to an alteration in the environment. In the process of adaptation, the individual or population of individuals adjusts to new circumstances, and has the advantageous quality which permits the organisms to live in the new surrounding. Adaptation at times results from the synthesis of a new enzyme or set of enzymes, or it may on occasion be linked to the formation of additional morphological features. Each organism has a certain adaptive capacity to the altered environments. In Saprolegniaceae, the dimorphism of the zoospore is a phenomenon which not only is physiologically and genetically controlled but also is an environmental adaptation. Motility may be omitted by adapting to the altering environments, such as in the case of bacterial contamination or the presence of certain chemical components in the habitat. The formation of chlamydospores (or gemmae) from vegetative hyphae is an adaptation phenomenon to the dry condition. The

chlamydospores or gemmae are the vegetative reproductive units that form to enable the cultures to adapt and survive unfavorable environments.

There are two possible adaptation mechanisms which are taken by the population to a new set of conditions. One is phenotypic adaptation, which is a temporary modification and can be readily reversed by a return to the original circumstances. The other is genotypic adaptation which requires genetic modification, the change is inherited by daughter cells. The genotypic adaptations result from mutation. This kind of genetic study in Saprolegniaceae heretofore received little attention. No experimental works are available. The variation in spore discharge is a phenoadaptation.

Interspecific Competition: Numerous organisms frequently arrive during the colonization of previously unpopulated sites, yet owing to the interactions initiated soon after growth commences at the site, few of the arrivals survive. This may be due to the process of competition. When the inhabiting biotic components are heterogenous, and the nutrients in the site are limited, the competition among the species is especially strong. Natural habitats of the aquatic fungi such as sewage treatment plants, fresh nutrients are constantly added. As a result, the species closely similar in nutrient requirement in a given site can grow without discernible competition if space is not limited.

In a laboratory study of two species with similar growth rates in axenic and in two-membered cultures, a critical point is reached where the available supply of some factor is exactly equivalent to that necessary to meet the demands of the two populations, thereafter the concentration or level of the factor is insufficient to allow for maximum growth rates. At this stage each population will get less of the new developing limiting factor than it would obtain if it was growing alone. Nevertheless one of the competitors will obtain or assimilate more of the limiting resource than the other; the latter, therefore, is more severely affected as a consequence.

The technique of freeing saprolegniaceous fungi from bacteria is an application of the result of growth competition, since the majority of isolates of these fungi (at least of Achlya) grow more rapidly on corn meal agar than the ubiquitous bacteria.

Intraspecific Competition: The struggle for the limited store of nutrients among individuals of the same species identifies survival. In axenic cultures, the density of cells usually rises until the supply of a component in the medium is exhausted. The evidence of competition in natural ecosystems is difficult to obtain. In the climax community, the operation of competition leads to a selection for better competitors and elimination of the less fit, so that much of the evidence may have been destroyed.

Parasitism: A parasite is an organism living on or in, and getting its food from its host, another living organism which is commonly injured in the process of parasitism. Two kinds of parasites can be designated, facultative parasites living independently as well as by parasitism and obligate parasites living on their living host for part or all of their life cycles. The so-called endoparasites live inside an organism; Ectoparasites, on the other hand, are localized on the external surface of their host. Parasitism in the Saprolegniaceae has been well studied. Literature reveals the list of the Saprolegniaceae parasites is so diverse as to suggest that any saprolegniaceous fungus might be capable of parasitism under proper conditions (Vishniac and Nigrelli, 1957). From the results obtained, at least 27 species in 10 genera of the family have been found capable of attacking animal hosts. Potential parasitism is a familial characteristic. But from an ecological point of view, the 12 of the 27 species not known to be involved in natural infections are not parasites. Many of the parasitic species of this family are pathogens on fish and fish eggs. Frog eggs have also been reported as the host of water molds as previously mentioned. The genus Aphanomyces was reported to contain several destructive parasites of the roots of vascular plants, causing serious diseases of sugar beets, peas, and other crops (Alexopoulos, 1966). This genus is particularly known in parasitism. Other saprolegniaceous fungi and pythiaceous fungi have been found to be the hosts (Madelin, 1973). In addition certain species of the water molds can be attacked by fungi other than the Saprolegniaceae. Species of Olpidiopsis, Petersenia, Pringsheimiella, Rhizidomyces, and the Legnidiales have been reported as the parasites (Milanez and DoVal, 1969, Papavizas and Davey, 1960).

Host-Parasite Relationship: Microorganisms differ markedly in their susceptibility to parasites and in the influence the invaders exert on them. Such differences are governed by inherent properties of the cells under attack, the virulence of the particular parasite, and prevailing environmental conditions.

If the host is viewed as an environment for the invader and the host-parasite relationship is essentially an interaction between a small organism and its habitat, then virulence is essentially a measure of the parasite's colonizing ability, and the resistance of the host may reflect the suitability of the environment for the invader. Tiffney (1939) found that there was a marked difference in the resistance of various species of hosts to the pathogen, Saprolegnia parasitica. In his experiment, some species of fish were found to have a very low resistance to the disease, some showed a somewhat greater resistance while others had a high resistance to the disease. Only Anguilla chrysypa was found to be immune.

Aphanomyces parasiticus invades mycelium, young sporangia and young oogonia of certain other saprolegniaceous fungi. It was reported that once a saprolegniaceous thallus begins to reproduce, it becomes immune to infection by Olpidiopsis incrassata (Slifkin, 1961). If made to resume vegetative growth, the thallus again becomes sus-

ceptible. This phenomenon suggests that the host at that particular stage would produce a chemical or possess a physical structure which prevents the pathogen from invading.

Infection of pink salmon with Saprolegnia was reported (Ivankow, 1971). Some diseased fish recovered which indicates the host may produce a toxin to the pathogen. The effects of the pathogen on the host are primarily the diverse symptoms produced by the hosts. In fatal infections of fish, hyphae often emerge from the gills and mouth in tufts over the body. In parasitism of other fungi, the host produced more or less morphological adaptation to the invader. The ultimate result is the death of the host, and the association between host and parasite disappears.

There is no specificity between the parasite and host of most members of the Saprolegniaceae. Saprolegnia parasitica is universally reported as a common parasite to numerous fish species. Nearly 35 species of fish have been reported susceptible to this pathogen. On the other hand, Vishniac and Nigrelli (1957) reported that 16 species of saprolegniaceous fungi infected platyfish. A few species of this family are obligate parasites although most of them are facultative parasites. Aphanomyces parasiticus, a saprolegniaceous organism was unable to grow when apart from its hosts (Coker, 1923).

Conclusion: In the association of parasitism, the parasites appear to gain two main advantages. They avoid competition for food from less specialized saprophytic fungi. To a certain extent they are protected from those changes in environmental conditions which are adverse to their mycelial growth. Success in parasitism may be judged by the extent to which these advantages are enjoyed. The characteristics of the parasites of Saprolegniaceae could be identified by three distinct features. The organism causes lesions and finally death of the host. Most of the species are capable of saprobic growth under natural conditions. Each species has a wide host range. Saprolegnia parasitica is universally reported as a common parasite, others are reported in frequency down to only a single established case. The reason for the rarity or absence of the parasitic habitat in some species probably may be found in their specific ecology. Tiffney (1939) in his study of hostrange of Saprolegnia parasitica suggested three possible causes of death to the host: the destruction of tissue, the formation of toxic materials, and the dilution or dehydration of body fluids resulting from the destruction of areas of protective epidermis. Species of Saprolegnia (predominantly S. parasitica) and Achlya are generally the predominant fungi associated with fish diseases in nature. The evidence for initiating primary infection on wholly uninjured fish, however, is not convincing. Vishniac and Nigrelli (1957) found that uninjured fish were not attacked.

Species belonging to the Saprolegniaceae have diverse yet specific habitats. Frequently these habitats influence the growth and development of the species. It is also equally evident that the est-

ablishment of saprolegniaceous fungi also influences and changes the habitat in which they are found. Numerous studies could be initiated to identify new habitats of the water molds and possibly locate new representative forms of the family. It is quite evident that increased dependence on aquatic habitats will be needed for the needs of human food resources. The aquatic fungi will certainly have influencial effects upon the aquatic environment as an area of crop production in the future.

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NEW TAXA AND NEW COMBINATIONS OF THELYPTERIS FROM GUATEMALA

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Prior to publication of a treatment of Thelypteris as part of the Ferns and Fern Allies of Guatemala (in Fieldiana:Botany), it is necessar to describe two new taxa and make several new combinations.

THELYPTERIS STOLZEANA A. R. Smith, sp. nov.

Rhizomata erecta, caudicibus ca. 1.0-1.5 cm. diametro; stipites fasciculati, 10-20 cm. longi, 1-2 mm. diametro, brunneoli, pilis stipitatis bifidis vel trifidis ca. 0.1 (0.2) mm. longis, necnon pilis paucis simplicibus, glabrescentes; laminae atrogriseo-virides, 15-25 cm. longae bipinnatifidae, ad apicem confluentem pinnatisectum gradatim reductae; rhachides sine gemmis; pinnae 8-9-jugae, sessiles, infimae (1-2 paria) leviter reductae deflexaeque, basi angustatae; pinnae maximae usque ad ca. 5 cm. longae, 1.5 cm. latae, incisae ca. 0.5-0.7, lobatae basi; segmenta subobliqua, non vel obscure falcata, 2-3 mm. lata, ad apicem rotundata vel truncata; venae 4-6-jugae, infimae duae marginem ad sinum attingentes, vel vena distali paris marginem intra 0.3 mm. sinus attingenti; rhachides costaeque infra pilis 2-4-fissis (paucis simplicibus), stipitatis, 0.1 (0.2) mm. longis; venae infra pilis simplicibus; paginae laminarum firmo-herbaceae, utrinque glabrae, non verrucosae; sori inframediales vel mediales, exindusiati; sporangia glabra.

Type: GUATEMALA, Dept. Alta Verapaz, along Río Carchá between Cobán and San Pedro Carchá, Standley 90107 (holotype F).

Paratype: MEXICO, Est. Chiapas, municipio La Trinitaria, Lagos de Montebello, Montane Rain Forest, Pine-Oak-Liquidambar forest, 1300 m., Breedlove 22355, with Smith (DS).

This species forms a probable evolutionary link between typical members of subg. Goniopteris, such as T. hatchii A. R. Smith, and T. blanda (Fée) Reed, thought by Christensen (1913) to belong to subg. Lastrea. Thelypteris blanda, the closest known relative of T. stolzeana has a few minute furcate hairs on the rachis (overlooked by Christensen) while T. stolzeana has much more obvious furcate to stellate hairs on th rachis and costae below. In addition, the two can be distinguished by the deeper cutting of the pinnae in T. blanda, the lowermost veins thus meeting the blade margin well above the sinus. Both species, along with T. hatchii and several other species of subg. Goniopteris, have a distinctive dark grayish-green blade color.

The floras of Alta Verapaz, Guatemala, and Lagos de Monte Bello, Chiapas, have much in common, both areas having a limestone substrate. Several species of ferns are known only from these two areas, e.g., Asplenium olivaceum A. R. Smith and Ctenitis lanceolata (Baker) A. R. Sm both apparently calcicolous.

The species epithet honors Mr. Robert G. Stolze, Field Museum of Natural History, who is preparing a floristic account of the pteridophytes of Guatemala.

THELYPTERIS MENISCIOIDES (Liebm.) Reed var. TERNATA A. R. Smith, var. nov.

Differt a var. meniscioides laminis plerumque ternatis 1 (3) paribus pinnarum lateralium, et sporangiis setosis pilis 0.1 mm. longis.

Type: GUATEMALA, Dept. Izabal, along Río Frío, "on rock", Steyermark 41644 (holotype F; isotypes GH, US).

Paratypes: GUATEMALA. Dept. Alta Verapaz, near Chirriacté on Petén Hwy., ca. 900 m., Standley 91861 (F); same locality, Standley 91624 (F). Dept. Izabal. Jocoló, Johnson 1125 (LA, US); between Escobas and Montaña Escobas, across bay from Puerto Barrios, 1-100 m., Steyermark 39294 (F).

Variety ternata is thus far known only from wet limestone forests of Guatemala, where it seems to be more common than the type variety, known from Oaxaca, Chiapas, Veracruz, Tabasco, and Guatemala. One collection (Steyermark 39294) has one frond with 2-1/2 pairs of lateral pinnae; all other collections have ternate fronds.

THELYPTERIS (subg. Goniopteris) MINOR (C. Chr.) A. R. Smith, comb. and stat. nov.

Basionym: Dryopteris nicaraguensis (Fourn.) C. Chr. var. minor C. Chr., Kongel. Danske Vidensk. Selsk. Naturvidensk. Math. Afh., VII. 10: 252. 1913. -Lectotype (chosen here): Guatemala, Alta Verapaz, Secanquim, Maxon & Hay 3196 (US!).

This species is known only from Guatemala. It seems closer to T. imbricata (Liebm.) Reed than to T. nicaraguensis, to which Christensen referred it. Thelypteris minor differs from the latter in the stalked (1-3 mm.) pinnae, the more abruptly reduced pinnae segments at the base of the lower pinnae, and in the darker gray-green color of the blades. True T. nicaraguensis is not known from Guatemala.

Specimens seen: GUATEMALA. Dept. Alta Verapaz. Near Finca Sepacuite, rd. from Secanquim to Sepacuite, Cook & Griggs 372 (US); Sebol, near Rubelquiche, Contreras 4250 (US); vicinity of Secanquim, Maxon & Hay 3217 (US); Salvin s.n. (GH); Cubilquitz, v. Turckheim s.n. (Donnell Smith, ed. 8646) (GH, US). Dept. Chiquimula. Vicinity of El Barriol, Steyermark 30825 (F). Dept. Izabal. 2-5 km. S of Izabal, Jones et al. 3075 (F, NY); Jocoló, Johnson 1041 (NY, US); vicinity of Escoba, Standley 24821 (US), 24881 (GH, US); La Jagua to Murcielago, Rowland et al. B-36 (F); between Bananera and "La Presa", Steyermark 38262 (F). Dept. Petén. Along Río Machaquila, N of El Cambio, Steyermark 45958 (F, US).

THELYPTERIS (subg. Goniopteris) PRAETERMISSA (Maxon) A. R. Smith, comb. nov.

Basionym: Dryopteris praetermissa Maxon, Proc. Biol. Soc. Wash. 57: 20. 1944.

THELYPTERIS (subg. Goniopteris) SCHIPPII (Weatherby) A. R. Smith, comb. nov.

Basionym: Dryopteris schippii Weatherby, Amer. Fern J. 25: 52. 1935

THELYPTERIS (subg. Amauropelta) CINEREA (Sodiro) A. R. Smith, comb. nov.

Basionym: Nephrodium cinereum Sodiro, Anales Univ. Centr. Ecuador 22: 103. 1908. Synonyms: Dryopteris sanctiformis C. Chr., Kongel. Danske Vidensk. Selsk. Naturvidensk. Math. Afh., VII. 10: 130. 1913. Thelypteris sanctiformis (C. Chr.) Reed, Phytologia 17: 312. 1968.

The type of Nephrodium cinereum is from Ecuador, Corazon, 8/903, Sodiro s.n. I have been unable to find type material at either K or P, but authentic and topotypic specimens agreeing with the original description are at P! (collected 12/907). These specimens show that N. cinereum is exactly the same as Thelypteris sanctiformis, known from southern Mexico to Ecuador.

THELYPTERIS (subg. Steiropteris) GLANDULOSA (Desv.) Proctor var. BRACHYODUS (Kunze) A. R. Smith, comb. and stat. nov.

Basionym: Polypodium brachyodus Kunze, Linnaea 9: 48. 1834. Synonym: Thelypteris brachyodus (Kunze) Ching, Bull. Fan Mem. Inst. Biol., Bot. 6: 286. 1936.

The type variety is confined to the Lesser Antilles and northern South America and differs slightly by its lighter green blades above, more falcate segments, and generally opposite pinnae. These differences are insufficient for recognition of T. brachyodus as a distinct species.

THELYPTERIS subg. MACROTHELYPTERIS (H. Ito) A. R. Smith, comb. and stat. nov.

Basionym: Thelypteris sect. Macrothelypteris H. Ito in Nakai and Honda, Nov. Fl. Jap. no. 4. 141. 1939. Macrothelypteris (H. Ito) Ching, Acta Phytotax. Sin. 8: 308. 1963.

For the purposes of a flora, I choose to recognize a broadly circumscribed genus Thelypteris with numerous well-defined subgenera. No name has heretofore been available at subgeneric rank for the naturalized Old World species Thelypteris torresiana (Gaud.) Alston.

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A New Name for *Cynoglossum erectum* (Boraginaceae)

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In volume 33 no. 6 of Phytologia I described *Cynoglossum erectum* Higgins. Recently Mr. Robert R. Mill of the University of Edinburgh at the Royal Botanical Garden, Scotland, brought to my attention that C. *erectum* was already validly published as a European plant of unknown origin. *Cynoglossum erectum* Schweigg ex Schrank, in Denkschr. Bot. Ges. Regensb. 2:29 (1822). The following new name is provided here.

Cynoglossum Henricksonii Higgins nom. nov. for *Cynoglossum erectum* Higgins Phytologia 33: No. 6, p. 111. 1976.

The new name is in honor of Dr. James Henrickson, a student and collector extraordinary of the Chihuahuan Desert Flora.

In this same paper there were two typographical errors in the description and citation of *Omphalodes Chaingii*. The leaf width is 7--14 mm broad and not 0.7--14 mm broad. Also the latitude is 29°04'--29°05' 30"N and not 29°04'--20°04' 30"N.

STUDIES IN THE AMARANTHACEAE

I. THE GENUS INDOBANALIA

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In undertaking a revision of the genus *Chamissoa*, the status of several closely related taxa were also investigated. This was done in order to facilitate coming to a better understanding of the relative phylogenetic position of *Chamissoa*. *Indobanalia* is one of several genera in the *Amaranthaceae* considered to be closely related to *Chamissoa*, although they are a world apart, geographically speaking. This is the first of what is hoped will be a series of papers that collectively will shed more light upon relationships within the family *Amaranthaceae*.

Indobanalia (Moquin) Henry & Roy

Indobanalia (Moquin) Henry & Roy, Bull. Bot. Serv. India 10:274 (1968).
Banalia Moquin in A. P. de Candolle, Prodromus 13(2): 278 (1849), non Rafin., Autikon Botanikon 50 (1840).

Suffrutescent or woody, sprawling or scandent shrubby plants with the branches often becoming vine-like. Leaves alternate, exstipulate, membranaceous, entire, ovate to lanceolate. Inflorescence paniculoid or spikoid, axillary and/or terminal, composed of cymose clusters of 1-5 flowers disposed alternately on the axes. Flowers each subtended by a bract and two bracteoles; sepals 5, subequal, ovate-subulate; stamens 5, with filaments united below and without sterile appendages alternating with them, and with 2-celled anthers; pistil with globose-oblong ovary with erect style about equal to the ovary in length and with linear, revolute stigmas with glandular hairs, & with 1 ovule attached to base of the ovary with an erect funiculus. Utricle globose & somewhat compressed, included within the sepals, membranaceous and indehiscent. Seed exarillate, black & shining at maturity and minutely reticulate, with annular embryo with linear cotyledons, and with farinose endosperm.

A monotypic genus restricted to the ghats and hills of southwestern India. Moquin (1849) described two species in his genus *Banalia*: *B. thyrsiflora* and *B. brasiliana*. The latter taxon was transferred by Fries (1920) to *Chamissoa* wherein it resided until Sohmer (1976) described a new genus based on that taxon.

Indobanalia most closely resembles Chamissoa subgenus Chamissoa in morphology and habit, but the exarillate seed, indehiscent utricle and bisexual flowers, distinguish it from that taxon.

Indobanalia thyrsiflora (Moquin) Henry & Roy, Bull. Bot. Serv. India 10:274 (1968).

Banalia thyrsiflora Moquin in A. P. de Candolle, Prodromus 13(2): 278 (1849); Wight, Icones 5: t. 1774 (1852); sensu Schinz in Engler & Prantl, DIE Natürl. Pfl.-fam. 3(1a): 101 (1893).

A suffrutescent, sprawling shrub whose branches often develop the habit of a leaning or scrambling vine to 5 m. Leaves with petioles 0.5 - 5.5 cm long, with ovate to lanceolate, membranaceous blades 1 x 4 cm - 7 x 13 cm wide and long, obtuse to round at the base and tapering into the petiole, acuminate to long-acuminate at the apex, with 5 - 7 pairs of lateral veins. Inflorescence paniculoid and either terminal with the leaves of the upper nodes strongly reduced, or truly lateral in the axils of normal foliage leaves, but frequently difficult to ascertain where terminal inflorescense begins, to 30 cm long if terminal, smaller if axillary and then often spikoid, composed of cymose clusters of 1 - 5 flowers alternately disposed on the inflorescence axes, with the younger flowers arising in the axils of the bracteoles of the older ones in each cluster. Flowers bisexual, at anthesis with the 5 ovate-subulate, white sepals 3.6 - 4.2 mm long and with the free portion of the filaments about 2 mm and anthers about 0.2 mm long; pistil at anthesis with oblong-globose ovary about 1.2 mm long, with style and stigmas each about the same length as the ovary. Utricle 1.5 - 2 mm long, indehiscent, but with lower portions of wall very thin and liable to irregular tearing. Seed 1.2 - 1.5 mm long, oblong-lenticular, black, shining and minutely reticulate at maturity.

Type: India: without further data, Wallich 6914a (BM, lectotype). Figure 1.

Specimens examined:

INDIA: Karnataka (formerly Mysore): Hassan Dist.: Neradi-Somvarpet Road, Ramamoorthy & Gandhi 2611 (US); Markanahalli, Saldanha 12,568 (US); Bisle Ghat, top section, Saldanha 16518 (US); Coorg Dist.: Cameron s.n. Mar 1899 (K). Kerala: Malabar Dist.: Manantoddy, Lawson s.n. Jan 1884 (K, 2 sheets). Tamil Nadu (formerly Madras): Nilgiri Mts: Coonoor, Clarke 10920 (K), Gamble 18365 (BM, K); Nilgiri Mts. without further data, Clarke s.n. (BM), Wight s.n. (K); Palni Hills, without further data, Beddome 6553, 6554 (BM); Tirunelveli Hills, without further data, Beddome 6552 (BM); Madras, without further data, Beddome 6551 (BM), collector unknown (K). INDIA: without further data, Beddome 6555 (BM), Gardner s.n. (K), Thompson 6914 (K), Wallich

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Figure 1. Indobanalia thyrsiflora (Moquin) Henry and Roy. Illustration of lectotype specimen, Wallich 6914a (BM). x½.

6914a (BM, lectotype), 6914b (BM), Wight 2440 (K).

This species assumes a striking resemblance to Chamissoa altissima, which is from the American tropics and subtropics, in habit. The two species have apparently exploited the same kinds of habitat...open and/or naturally or artifically disturbed situations. Indobanalia thyrsiflora is apparently found mostly in the transition zone between the lower elevation dry, deciduous forests, and the higher, wetter, evergreen forests of the ghats and hills of southwestern India (fig. 2) between about 600 - 1200 m elevation, particularly where the forest has been disturbed. It is an interesting isolated representative of a matrix of species that form a more or less well-defined group within the Amaranthaceae and will most likely assume considerable importance in an ultimate attempt to understand evolution within this family.

Acknowledgements

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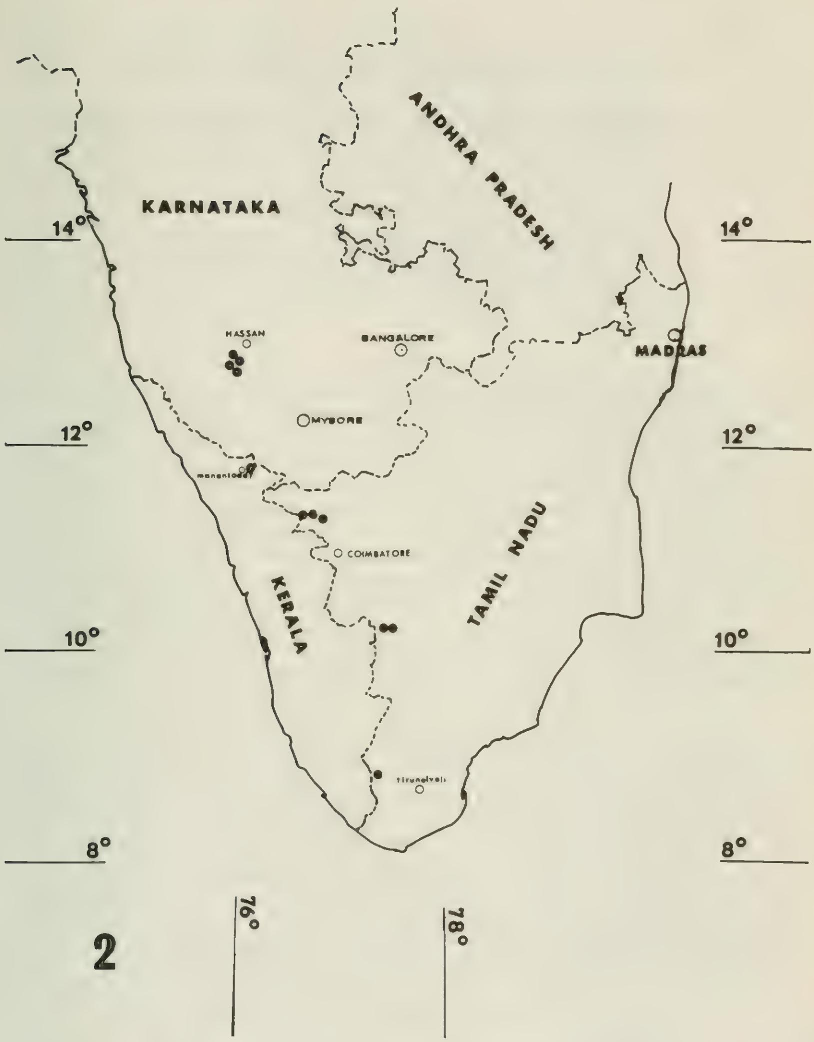

Figure 2. Map of Southern India demonstrating general distribution (black dots) of <u>Indobanalia thyrsiflora</u> (Moquin) Henry and Roy.

THE IDENTIFICATION OF CULTIVATED PLANTS

I. A GENERAL COMMENTARY ON BOTANICAL IDENTIFICATION

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The value of the correct determination of the identity of unknown plants cannot be over-emphasized, and botanical identification in general is about the most immediately rewarding branch of taxonomic research. However, it has for long been bedevilled with some serious misconceptions and erroneous presentational procedures which seem to have driven most taxonomists away from it. For instance, the fact that some taxonomists insist on the use of minutiae of plant characters (particularly from the flower) in key-construction has given other taxonomists as well as the users of those keys the wrong impression that all plant characters are difficult to observe. Furthermore, the use of ambiguous descriptive terms in keys led to different personal interpretations and, consequently, to kaiotic and contradictory identifications. Another disconcerting feature of botanical keys to date is the definition of the contrasted pair of entries in the same couplet using different characters, thus rendering the comparison between them almost impossible. For example, it is not infrequent to find that one entry in the key is defined by one or a few features from the leaves while its alternative in the same couplet is diagnosed by a set of petal or stamen characters. These and many more of the common ills of botanical identification have been discussed in some detail by numerous authors (e.g. Davis and Heywood, 1963; Lawrence, 1959; Morse, 1971; Porter, 1959; Swingle, 1946), but they continue to feature prominently in identificatory keys up to the present.

Furthermore, the identification of cultivated plants has so far been grossly neglected: nearly all taxonomists concerned with botanical identification have concentrated their efforts on wild plants (which might be of some potential economic value), so that hardly any part of the world is not covered now by at least one floristic study. In doing so, they have unduly overlooked the much fewer

(and hence more manageable) plants which are currently in cultivation, although some of these plants (e.g. legumes, cereals) seem indispensible for the livelyhood of mankind. This obvious escape of taxonomists from tackling this evidently remunerative subject may well be due to the following:

(i) The work with cultivated plants is mostly carried out at the infra-specific, specific or (at best) generic levels, and there is generally no denial that the lower the hierarchical rank of the taxa under investigation the narrower the range of variation in their characters becomes. This means that the discovery of the variation needed for the discrimination between the various taxa would be beset with more difficulties when dealing with, say, the different varieties of wheat than with the genera and species of the Gramineae as a whole.

(ii) The range of variation suitable for use as basis for key-construction is further limited by the fact that the characters of cultivated plants are mostly unstable and liable to change with the change in environmental conditions. However, this phenomenon is by no means applicable to all aspects of variation in cultivated plants, and if work is primarily concentrated on only those plants which have been in cultivation long enough for their characters to stabilize genetically, the keys based on them would at least be fairly reliable. In any case, further periodical revision of those keys is a necessity (the same as for wild plants), and should adequately cater for any alteration in the plants' attributes as well as for any new plants which might have been domesticated or produced by the hybridization of previously grown crops.

(iii) It has always been generally felt that identificatory keys for cultivated plants are 'short-lived' as they will remain valid only as long as the plants they incorporate are in current usage. In other words, the construction of identificatory keys for cultivated plants does not deserve the time and effort expended on it. But this view is refutable on the grounds that the value of knowing the correct identity of any cultivated plant is vitally essential to a wide variety of people ranging from the growers, breeders, users and those using the plant in the various fields of scientific research.

(iv) If the scope of identification of cultivated plants is expanded so that the work is carried out without any geographical limitations imposed on the choice of plants, there is the difficulty of acquiring specimens of these plants from the various parts of the world where they are grown. It is rather unfortunate that only a small minority of

of herbaria in the world keep specimens of cultivated plants; despite their evident economic importance, cultivated plants have for long been stigmad as 'second-class' and unworthy of a place among the huge collections of wild plants in herbaria and seed collections. This curious fact can only mean that those interested in the identification of cultivated plants have to make additional efforts to collect their own specimens, and it seems that so far only very few taxonomists and plant collectors have been prepared to make these efforts.

(v) The basic problem of knowing the correct identity of the cultivated plants involved in a key prior to its construction seems formidable indeed. It also highlights the almost total lack of any records of the plants' characters and their correct and complete names. At present, it seems that one cannot ensure the true identity of an unknown variety or hybrid of cultivated plants except through the curtosy of its original producer; an exceedingly lengthy, time-consuming and laborious process which is not always possible or attainable to most users of cultivated plants.

In view of the foregoing remarks, a major project has been set up to construct non-indented dichotomous keys to cultivated members of such widely grown and economically important genera as Gossypium, Linum and Triticum. The keys to species and varieties of the former two genera have already been published (El-Gazzar et al, 1975 and 1976; Sallouma et al, 1975; Momtaz et al, 1976), while those covering the wheats will appear in subsequent numbers of this series. In this project, the plants' characters are recorded in a strictly comparative fashion. The resulting data-matrices are permanent records of the plants and their attributes, and can be readily subjected to future methods of key-generation as they come to light. Another novel feature of this project is the construction of alternative keys to the same group of plants, so that they may be used not only in their identification but also in the confirmation of that identification. Confirmatory keys of this sort have the added advantage of replacing the lengthy (and often far from comparative) descriptions which usually follow identificatory keys in most floristic works.

It seems that the identification of cultivated plants has a long way to go before catching up with the numerous improvments and innovations (e.g. data-banks and computer programs for key-generation; see Morse, 1968 and 1971; Goodall, 1968; Pankhurst, 1970a and b; Hall, 1970; Watson and Milne, 1972; Pettigrew and Watson, 1973) introduced to botanical identification but directed entirely to wild

plants. However, unless taxonomists begin to realize that the identification of cultivated plants has been unduly neglected for so long and that it is high time they devoted part of their efforts to it, one cannot possibly hope for any drastic changes in this unlikely state of affairs. With this in mind, our project seems to be a step in right direction, as it is meant to draw the attention of taxonomists, agronomists and horticulturists to the almost total lack of identificatory means for the great majority of cultivated plants and to set an example of how easily this huge gap in taxonomic practice can be bridged.

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NOTES ON NEW AND NOTEWORTHY PLANTS. XCI

Harold N. Moldenke

CITHAREXYLUM LOJENSE Moldenke, sp. nov.

Arbor foliis ellipticis petiolatis 9—22 cm. longis 5.5—7 cm. latis acuminatis integris ad basin acuminatis utrinque subglabratis vel minutissime pulverulentis, inflorescentiis solitariis terminalibus in maturitate nutantibus ca. 18 cm. longis.

A tree about 8 m. tall, the trunk about 25 cm. in diameter at breast height; branchlets slender, brownish-gray, obtusely tetragonal, many-striate, subglabrate or very minutely pulverulent; leaves decussate-opposite; old leaf-scars large, prominent, corky, ascending; petioles short, about 1 cm. long, sulcate above and slightly margined, subglabrate or minutely pulverulent-puberulent; leaf-blades elliptic, 9—22 cm. long, 5.5—7 cm. wide, conspicuously acuminate at both apex and base, entire, subglabrate or very minutely pulverulent on both surfaces, with 2 rather small inconspicuous sunken glands at the base beneath; flowers not seen; fruit in terminal, solitary, nutant racemes about 18 cm. long; peduncle short, slender, about 2 cm. long, lenticellate, subglabrate; rachis slender, subglabrate, striate, lenticellate; pedicels in fruit about 1 mm. long; fruiting-calyx campanulate, about 5 mm. long and wide, varying from erose-margined to shallowly or rather deeply lobed.

The type of this species was collected by Alfredo Samaniego V. and Francisco A. Vivar C. (no. 46) in a dry subtropical forest at Roblones, 40 km. northeast of Zapotillo, Loja, Ecuador, at an altitude of 900 meters, on August 8, 1975, and is deposited in my personal herbarium, at present at Plainfield, New Jersey. The collectors record the vernacular name, "sobo sobo".

CLERODENDRUM LINDLEYI var. PANICULATUM Moldenke, var. nov.

Haec varietas a forma typica speciei inflorescentiis perspicue paniculatis multiseriatis usque ad 24 cm. altis recedit.

This variety differs from the typical form of the species in having its inflorescences very plainly and conspicuously paniculate, consisting of about 12 or more pairs of opposite cymes in longitudinal series, the whole to about 24 cm. tall, the individual cymes long-pedunculate, many-flowered, and conspicuously bracteate.

The type of this variety was collected by Clair Alan Brown (no. 3887) along "New Roads", near Anchor, Pointe Coupee Parish, Louisiana, on October 22, 1932, and is deposited in the herbarium of Louisiana State University at Baton Rouge, Louisiana. The collector describes the plant as having "5 petals, pinkish seed, 4 stamens, stocky, strong odor".

STACHYTARPHETA JAMAICENSIS f. ATROCOERULEA Moldenke, f. nov.

Haec forma a forma typica speciei differt foliorum laminis plerumque maioribus late ellipticis usque ad 5.5 cm. latis non griseo-caeruleo-viridibus (in statu vivo) et corollis perspicue atrocoeruleis vel purpureis.

This form differs from the typical form of the species in usually having its leaf-blades conspicuously larger and broader, elliptic or broadly elliptic in outline, deeply and irregularly toothed, and not at all grayish- or bluish-green when fresh and the corollas conspicuously darker, dark violet-blue or purple.

The type of this form was collected by F. R. Fosberg (no. 56084), common in dense mat of herbaceous vegetation on "berm" or sand flat back of narrow beach, badly disturbed, at Fort Sherman, Torro Point, south of the west (Atlantic) end of the Panama Canal, altitude 1 m. at most, Canal Zone, Panama, on February 28, 1976, and is deposited in the United States National Herbarium at Washington. The collector notes "Rather depressed herb, leaves not grayish and flowers much darker violet than usual for S. jamaicensis."

VITEX MORONENSIS Moldenke, sp. nov.

Arbor, foliis oppositis 5—7-foliolatis, petiolis gracillimis 9—10 cm. longis minutissime puberulis, foliolis anguste ellipticis usque ad 16 cm. longis 5.5 cm. latis utrinque glabris ad apicem longe acuminatis ad basin acutis, petiolulis perspicue elongatis usque ad 4 cm. longis.

Tree, about 15 m. tall; trunk about 15 cm. in diameter at breast height; branchlets slender, light-gray, obtusely tetragonal or slightly flattened, glabrous, the youngest parts more or less pulverulent-puberulent; leaves decussate-opposite, long-petiolate, 5—7-foliolate; petioles very slender, 9—10 cm. long, very minutely puberulent; petiolules very slender, to 4 cm. long on the central leaflet, proportionately shorter on the lateral leaflets, glabrous, slightly sulcate or canaliculate above; leaflet-blades elliptic, submembranous, the central one to 16 cm. long and 5.5 cm. wide, rather long-acuminate at the apex, entire, acite at the base, glabrous on both surfaces, the venation rather obscure above and long lightly prominulous beneath, very slender; flowers and fruit not seen.

The type of this species was collected by Elbert L. Little, Jr., Alberto T. Ortega U., Alfredo Samaniego V., and Francisco A. Vivar C. (no. 548) in wet tropical Amazonian forest at Puerto Morona, east of Río Morona, province of Morona Santiago, Ecuador, at an altitude of 300 meters, on October 1, 1975, and is deposited in my personal herbarium at present at Plainfield, New Jersey. The collectors record the vernacular names, "pechiche" and "titimum".

A FIFTH SUMMARY OF THE VERBENACEAE, AVICENNIACEAE, STILBACEAE, DICRASTYLIDACEAE, SYMPHOREMACEAE, NYCTANTHACEAE, AND ERIOCAULACEAE OF THE WORLD AS TO VALID TAXA, GEOGRAPHIC DISTRIBUTION, AND SYNONYMY.

Supplement 6

Harold N. Moldenke

Since the publication of the 5th supplement to the above work in PHYTOLOGIA, volume 31, number 5, on August 11, 1975, 5,070 new herbarium specimens have come to me from 24 institutional and private herbaria on five continents. This new material, in addition to a vast amount of new literature which has been examined by my wife and/or myself, has brought to light numerous new taxa, new geographic records, new invalid names and spellings, and additional emendations and corrections of former entries. These are presented herewith (as promised on page 974 of the original work).

Herbarium specimen or literature citations substantiating these records are presented, as usual, in my monographs of the genera involved or in their periodic supplements, mostly published in PHYTOLOGIA. Citation to place of publication of the names listed in Part II are also given in these monographs or their supplements.

Note: "Avicennia marina var. resinifera (Forst.) Bakh." should be changed to read "Avicennia marina var. resinifera (Forst. f.) Bakh." in every place on the 13 pages where it occurs in the original work or in its supplements previous to this one.

Addenda & errata to Part I: The known geographic distribution of the accepted taxa:

UNITED STATES OF AMERICA:

New York:

xVerbena engelmannii Moldenke [Suffolk County]

Verbena urticifolia var. leiocarpa Perry & Fernald [Schuyler County]

New Jersey:

Verbena simplex Lehm. [Atlantic County]

Virginia:

Verbena hastata L. [Pittsylvania County]

Verbena urticifolia L. [Pittsylvania County]

Verbena urticifolia var. leiocarpa Perry & Fernald [Surrey County]

South Carolina:

Callicarpa americana L. [Turtle Island]

Lantana camara var. mista (L.) L. H. Bailey [Beaufort & Charleston Counties]

Lantana camara var. splendens (Medic.) Moldenke [Orangeburg County]

Georgia:

Lantana camara var. mista (L.) L. H. Bailey [Sea Island]

Lantana camara var. splendens (Medic.) Moldenke [Saint Simon's Island]

Verbena bonariensis L. [Spalding County]

Florida:

Avicennia germinans (L.) L. [Biscayne, Crawfish, Mangrove, & Ragged Keys]

Callicarpa americana L. [Sanibel Island]

Citharexylum fruticosum var. villosum (Jacq.) O. E. Schulz [Biscayne Key]

Clerodendrum indicum (L.) Kuntze [Biscayne Key & Sanibel Island]

Clerodendrum philippinum Schau. [Monroe County]

Clerodendrum umbellatum var. speciosum (Dombrain) Moldenke [Seminole County]

Duranta repens L. [Largo Key]

Eriocaulon compressum Lam. [Gilchrist County]

Lantana camara var. splendens (Medic.) Moldenke [Manatee & Palm Beach Counties]

Lantana camara var. ternata Moldenke [Manatee County]

Lantana depressa Small [Collier County]

Lantana involucrata L. [Ramrod Key]

Phyla nodiflora (L.) Greene [Mullet Key]

Phyla strigulosa var. sericea (Kuntze) Moldenke [Dade County]

Syngonanthus flavidulus (Michx.) Ruhl. [Nassau County; Pine Island]

Verbena maritima Small [Long Key]

Vitex trifolia var. subtrisecta (Kuntze) Moldenke [Indian River County]

Alabama:

Phyla nodiflora (L.) Greene [Dauphin Island]

Verbena brasiliensis Vell. [Montgomery County]

Mississippi:

Syngonanthus flavidulus (Michx.) Ruhl. [Holmes County]

Ohio:

Verbena hastata L. [Auglaize County]

Indiana:

Verbena hastata var. scabra Moldenke [Tippecanoe County]

Tennessee:

Verbena simplex Lehm. [Morgan County]

Verbena simplex var. eggerti Moldenke [Davidson County]

Michigan:

Phyla lanceolata (Michx.) Greene [Branch County]

Verbena bracteata Lag. & Rodr. [Grand Traverse County]

xVerbena engelmannii Moldenke [Ingham County]

Verbena hastata L. [Macomb & Otsego Counties]
Verbena stricta Vent. [Antrim & Macomb Counties]

Wisconsin:
Verbena canadensis (L.) Britton [Walworth County]
xVerbena moechina Moldenke [Rock County]
Verbena officinalis L. — to be deleted
xVerbena perriana Moldenke [Marquette County]
Verbena simplex var. eggerti Moldenke [Walworth County]
Verbena urticifolia L. [Jefferson County]

Kansas:
Verbena bipinnatifida Nutt. [Leavenworth County]
Verbena hastata var. scabra Moldenke [Dickinson County]

Missouri:
Phyla lanceolata (Michx.) Greene [Oregon County]
xVerbena moechina Moldenke [Reynolds County]
Verbena stricta Vent. [Cass County]

Arkansas:
Callicarpa americana L. [Stone County]
Phyla nodiflora var. texensis Moldenke [Crawford & Jefferson Counties]
Verbena bipinnatifida Nutt. [Little River County]
Verbena bracteata Lag. & Rodr. [Carroll County]
Verbena brasiliensis Vell. [Lincoln County]
Vitex agnus-castus L. [Nevada County]

Louisiana:
Clerodendrum bungei Steud. [East Baton Rouge, Pointe Coupee, & Tangipahoa Parishes]
Clerodendrum indicum (L.) Kuntze [Lafourche Parish]
Clerodendrum lindleyi var. paniculatum Moldenke [Pointe Coupee Parish]*
Duranta repens L. [Tangipahoa Parish]
Eriocaulon decangulare L. [Jackson Parish]
Lantana camara var. mista (L.) L. H. Bailey [Acadia, Ascension, East Baton Rouge, Iberia, Orleans, Saint Mary, & Saint Tammany Parishes; Avery & Avoca Islands]
Lantana camara f. parvifolia Moldenke [Saint Charles Parish]
Lantana camara var. splendens (Medic.) Moldenke [Ascension, Jefferson, Orleans, Saint Charles, Saint Mary, & West Feliciana Parishes]
Lantana montevidensis (Spreng.) Briq. [Saint Mary Parish]
Lantana tiliaefolia Cham. [Jefferson Parish; Grand Isle]
Phyla lanceolata (Michx.) Greene [Ascension, Bossier, Cameron, Iberville, Jefferson Davis, Lafayette, Ouachita, Rapides, Tangipahoa, & West Feliciana Parishes]
Phyla nodiflora (L.) Greene [Assumption & Lafayette Parishes; Grand & Shell Islands]
Phyla nodiflora var. texensis Moldenke [Bossier & East Feliciana Parishes]

Stylodon carneus (Medic.) Moldenke [Saint Helena & Tangipahoa Parishes]
xVerbena alleni Moldenke [LaSalle, Pointe Coupee, & Saint Helena Parishes]*
Verbena bipinnatifida Nutt. [LaSalle Parish]
Verbena bonariensis L. [Cameron, Iberia, Lafayette, Livingston, Pointe Coupee, Saint Mary, & Vermilion Parishes]
Verbena brasiliensis Vell. [Acadia, Saint Helena, Tangipahoa, & West Feliciana Parishes]
Verbena canadensis (L.) Britton [Ascension, Bossier, Caddo, Pointe Coupee, & Saint John the Baptist Parishes]
Verbena halei Small [East Baton Rouge, Jefferson Davis, Lafayette, Saint Charles, Saint Helena, Saint Mary, Terrebonne, Vermilion, & West Feliciana Parishes]
Verbena montevidensis Spreng. [Calcasieu, Cameron, East Baton Rouge, Jefferson Davis, Lafayette, Saint Landry, Tangipahoa, & Vermilion Parishes]
Verbena rigida Spreng. [Lafayette, Livingston, Ouachita, Pointe Coupee, Saint Helena, Saint Landry, Tangipahoa, & Union Parishes]
Verbena scabra Vahl [Catahoula, Jefferson, Pointe Coupee, Saint James, Saint Tammany, & West Feliciana Parishes; Grand Isle]
Verbena tenuisecta Briq. [Acadia, Rapides, Saint Helena, & Saint Tammany Parishes]
Verbena tenuisecta var. alba Moldenke [Saint Tammany Parish]
Verbena urticifolia L. [Lafayette, Pointe Coupee, Saint Helena, Tangipahoa, Terrebonne, & West Feliciana Parishes]
Verbena xutha Lehm. [Assumption, Calcasieu, Iberia, Lafayette, Madison, Pointe Coupee, Saint Mary, & West Feliciana Parishes; Choupique, Grand, & Turnbull Islands]
Vitex agnus-castus L. [East Baton Rouge & Tangipahoa Parishes]
Vitex agnus-castus var. caerulea Rehd. [Catahoula Parish]
Vitex agnus-castus f. rosea Rehd. [Winn Parish]

Nebraska:
Phyla lanceolata (Michx.) Greene [Colfax County]
Verbena bracteata Lag. & Rodr. [Pierce & Polk Counties]
Verbena hastata var. scabra Moldenke [Pierce County]

Oklahoma:
Phyla nodiflora var. texensis Moldenke [Alfalfa, Jefferson, Kiowa, & Pittsburg Counties]
Verbena bracteata Lag. & Rodr. [Marshall County]
xVerbena deamii Moldenke [Marshall County]
Verbena hastata var. scabra Moldenke [Ottawa County]
xVerbena illicita Moldenke [Marshall County]
xVerbena perriana Moldenke [Marshall County]

Texas:
Aloysia gratissima f. macrophylla Moldenke — delete the asterisk

Citharexylum spathulatum Moldenke & Lundell — delete the asterisk
Phyla nodiflora var. incisa (Small) Moldenke [Austin, Erath, Hidalgo, Jackson, Jefferson, Jim Hogg, Matagorda, Navarro, Orange, Travis, Vistoria, Washington, & Webb Counties; El Toro & Horse Islands]
Phyla nodiflora var. texensis Moldenke [Cooke , Karnes, & Red River Counties]
Verbena canescens H.B.K. [Tarrant County]
Verbena canescens var. roemeriana (Scheele) Perry [Caldwell County]
Verbena delticola Small [Nueces County]
Verbena halei f. parviflora Moldenke [Galveston Island]*
Verbena hastata var. scabra Moldenke [Hutchinson County]
Verbena xutha Lehm. [Orange County]

Arizona:
Verbena ehrenbergiana Schau. — to be deleted
Verbena wrightii A. Gray [Santa Cruz County]

California:
Verbena lasiostachys Link [Humboldt County]

CHANNEL ISLANDS:
Verbena bracteata Lag. & Rodr. [Santa Catalina]

MEXICO:
Aloysia gratissima f. macrophylla Moldenke [Chihuahua]
Bouchea spathulata var. longiflora Moldenke [Chihuahua]
Citharexylum cooperi Standl. [Chiapas]
Citharexylum spathulatum Moldenke & Lundell [Chihuahua, San Luis Potosí, & Zacatecas]
Lantana achyranthifolia Desf. [Querétaro]
Lantana camara var. moritziana (Otto & Dietr.) López-Palacios [Tabasco]
Lantana camara f. parvifolia Moldenke [Jalisco & San Luis Potosí]
Lantana camara var. splendens (Medic.) Moldenke [Chiapas & Veracruz]
Lantana horrida H.B.K. [Querétaro]
Lantana macropoda Torr. [Zacatecas]
Lantana velutina f. violacea Moldenke [Jalisco]
Lippia controversa var. brevipedunculata Moldenke — delete the asterisk
Lippia curtisiana Moldenke [Coahuila]
Petrea volubilis L. [México]
Phyla cuneifolia (Torr.) Greene [Chihuahua]
Phyla nodiflora (L.) Greene [Chiapas]
Phyla strigulosa var. sericea (Kuntze) Moldenke [Chihuahua]
Stachytarpheta angustifolia (Mill.) Vahl [Chiapas]
Stachytarpheta jamaicensis f. atrocoerulea Moldenke [Veracruz & Yucatán]

Verbena amoena Paxt. [Chihuahua]
Verbena bonariensis L. [Federal District]
Verbena canescens H.B.K. [Jalisco]
Verbena ciliata var. longidentata Perry [Chihuahua, Nuevo León, & Zacatecas]
Verbena ehrenbergiana Schau. — add an asterisk
Verbena gentryi Moldenke [Chihuahua]
Verbena longifolia f. albiflora Moldenke [Veracruz]
Verbena neomexicana var. hirtella Perry [Zacatecas]
Verbena quadrangulata Heller [Coahuila]
Verbena rinconensis Moldenke [Zacatecas]
Vitex gaumeri Greenm. [Quintana Roo]
Vitex hemsleyi Briq. [Jalisco]

CAMPECHE BANK:
Avicennia germinans (L.) L. [Alacran]

GUATEMALA:
Lantana hispida H.B.K. [Retalhuleu]
Stachytarpheta frantzii Polak [Izabal]

BELIZE:
Callicarpa acuminata var. argutedentata Moldenke
Lantana camara var. moritziana (Otto & Dietr.) López-Palacios
Lantana camara var. splendens (Medic.) Moldenke
Stachytarpheta jamaicensis f. atrocoerulea Moldenke

HONDURAS:
Aegiphila falcata Donn. Sm.
Aegiphila fasciculata Donn. Sm.
Aegiphila skutchii Moldenke
Eriocaulon seemannii Moldenke
Lantana camara var. splendens (Medic.) Moldenke
Lippia graveolens H.B.K. [Choluteca]
Lippia oxyphyllaria (Donn. Sm.) Standl.
Petrea aspera Turcz.
Phyla betulaefolia (H.B.K.) Greene
Phyla stoechadifolia (L.) Small
Verbena tenuisecta Briq.

GULF OF HONDURAS ISLANDS:
Citharexylum caudatum L. [Hunting]
Lantana involucrata var. odorata (L.) Moldenke [Chapel]
Phyla nodiflora var. incisa (Small) Moldenke [Lame]
Phyla nodiflora var. longifolia Moldenke [Frank's, Hunting, & Seal]

NICARAGUA:
Avicennia germinans (L.) L. [Managua]
Cornutia grandifolia (Schlecht. & Cham.) Schau. [Estelí & Granada]
Ghinia spicata (Aubl.) Moldenke [Cabo Gracias a Díos]
Lantana camara var. splendens (Medic.) Moldenke [Managua]

Lantana velutina Mart. & Gal. [Estelí]
Lippia controversa var. brevipedunculata Moldenke [Granada]
Lippia myriocephala var. hypoleia (Briq.) Moldenke [Estelí]
Stachytarpheta frantzii Polak. [Granada]

COSTA RICA:

Aegiphila cephalophora Standl. [Heredia]
Aegiphila panamensis Moldenke [Heredia]
Lantana camara var. splendens (Medic.) Moldenke [Limón]
Lippia costaricensis Moldenke [Heredia]
Stachytarpheta jamaicensis f. atrocoerulea Moldenke [Limón]

PANAMA:

Aegiphila cephalophora Standl. [Darién] — delete the asterisk
Aegiphila pauciflora Standl. [Darién]
Citharexylum viride Moldenke [Veraguas]
Stachytarpheta jamaicensis (L.) Vahl [Darién]
Stachytarpheta jamaicensis f. atrocoerulea Moldenke [Bocas del Toro, Canal Zone, Chiriquí, & Colón; Taboga Island]
Tectona grandis f. punctata Moldenke [Canal Zone]
Tonina fluviatilis Aubl. [Veraguas]

BAHAMA ISLANDS:

Avicennia germinans (L.) L. [Drunkenman's, Gun, Southeast, & Well's]
Bouchea prismatica (L.) Kuntze [Deadman's]
Callicarpa hitchcockii Millsp. — to be deleted
Callicarpa lancifolia Millsp. [Andros, Cat, Eleuthera, & New Providence]
Citharexylum caudatum L. [Eleuthera]
Citharexylum fruticosum L. [Crooked]
Citharexylum fruticosum f. bahamense (Millsp.) Moldenke [North Andros & San Salvador]
Citharexylum fruticosum var. smallii Moldenke [South Andros]
Citharexylum fruticosum var. subvillosum Moldenke [Walker's; — delete "San Salvador"]
Duranta repens L. [North Andros]
Lantana bahamensis Britton [Great Abaco & Paradise]
Lantana balsamifera Britton [South Andros]
Lantana camara L. [Eleuthera]
Lantana camara var. mutabilis (Hook.) L. H. Bailey [Cat & Eleuthera]
Lantana camara var. splendens (Medic.) Moldenke [Eleuthera, Grand Bahama, & Great Harbour]
Lantana demutata Millsp. [Great Inagua] — delete the asterisk
Lantana involucrata L. [Walker's]
Lantana involucrata f. rubella Moldenke [Eleuthera]
Petitia domingensis var. poeppigii (Schau.) Moldenke [Eleuthera]
Phyla nodiflora (L.) Greene [Walker's]
Phyla nodiflora var. reptans (Spreng.) Moldenke [Deadman's]

Phyla stoechadifolia (L.) Small [Crooked & Eleuthera]
Vitex trifolia var. subtrisecta (Kuntze) Moldenke [San Salvador]

TURKS AND CAICOS ISLANDS:
Avicennia germinans (L.) L. [Providenciales]
Citharexylum fruticosum var. subvillosum Moldenke [North Caicos]
Lantana bahamensis Britton [Middle Caicos & Providenciales]
Lantana demutata Millsp. [West Caicos]
Lantana involucrata f. rubella Moldenke [Grand Turk, North Caicos, Pine, & Providenciales]
Phyla stoechadifolia (L.) Small [North Caicos]
Stachytarpheta jamaicensis (L.) Vahl [North Caicos & Providenciales]

CUBA:
Callicarpa lancifolia Millsp. -- delete the asterisk
Eriocaulon ovoideum Britton & Small [Oriente]
Lantana parvifolia Desf. — delete the asterisk
Paepalanthus pungens var. brevifolius Moldenke [Pinar del Río]
Verbena officinalis L. [Havana & Matanzas]

ISLA DE PINOS:
Eriocaulon ovoideum Britton & Small — delete the asterisk
Lantana camara var. ternata Moldenke — delete the asterisk

JAMAICA:
xCitharexylum hybridum Moldenke
Lantana involucrata var. odorata (L.) Moldenke

HISPANIOLA:
Lantana exarata Urb. & Ekm. — delete the asterisk
Lantana leucocarpa f. anomala Moldenke [Dominican Republic]*
Lantana parvifolia Desf. [Dominican Republic]
Verbena domingensis f. foliosa Moldenke [Dominican Republic]*

PUERTO RICO:
Lantana exarata Urb. & Ekm.
Tectona grandis f. tomentella Moldenke

VIRGIN ISLANDS:
Bouchea prismatica var. brevirostra Grenz. [St. Croix]

WINDWARD ISLANDS:
Lantana camara var. moritziana (Otto & Dietr.) López-Palacios [Grenada, Martinique, & St. Vincent]
Lantana trifolia f. oppositifolia Moldenke [St. Vincent]
Tectona grandis f. canescens Moldenke [Barbados]

TRINIDAD AND TOBAGO:
Lantana camara var. splendens (Medic.) Moldenke [Tobago & Trinidad]

COLOMBIA:
Aegiphila caucensis Moldenke [Arauca]
Aegiphila elata Sw. [Caldas]
Aegiphila elata var. macrophylla (H.B.K.) López-Palacios [Ar-

auca]

Aegiphila glandulifera Moldenke [Meta]

Aegiphila grandis Moldenke [Caldas & Santander]

Aegiphila integrifolia (Jacq.) Jacq. [Córdoba & Cundinamarca]

Aegiphila integrifolia var. guianensis (Moldenke) López-Palacios [Arauca & Nariño]

Aegiphila laeta H.B.K. [Arauca]

Aegiphila mollis H.B.K. [Arauca]

Aegiphila sessiliflora var. cuatrecasasi Moldenke [Valle del Cauca]

Aegiphila ternifolia f. oppositifolia López-Palacios [Santander] — this is the corrected entry

Aegiphila truncata Moldenke [Santander]

Avicennia germinans (L.) L. [delete "Nariño" & "Valle del Cauca"]

Avicennia germinans var. guayaquilensis (H.B.K.) Moldenke [Antioquia & Chocó]

Bouchea boyacana Moldenke [Cundinamarca & Valle del Cauca]

Bouchea prismatica (L.) Kuntze [Santander]

Callicarpa acuminata H.B.K. [Córdoba]

Citharexylum macrophyllum Poir. [Arauca]

Citharexylum ulei Moldenke — to be deleted

Citharexylum ulei var. obovatum Moldenke [Antioquia, Córdoba, & Putumayo]*

Clerodendrum ternifolium var. velutinosum Moldenke [Tolima]*

Cornutia odorata var. colombiana Moldenke [Arauca & Sucre]

Duranta mutisii L. f. [Norte de Santander]

Duranta repens L. [Córdoba]

Duranta tomentosa Hayek [Cauca]

Lantana armata Schau. [Córdoba & Santander]

Lantana armata var. velutina Moldenke [Cauca, Nariño, & Norte de Santander]

Lantana camara var. flava (Medic.) Moldenke [Santander]

Lantana camara var. moritziana (Otto & Dietr.) López-Palacios [Arauca]

Lantana camara var. moritziana f. parvifolia (Moldenke) López-Palacios [Cundinamarca, Nariño, & Tolima]

Lantana colombiana López-Palacios [Cauca, Cundinamarca, Nariño, & Tolima]

Lantana cujabensis Schau. [Amazonas]

Lantana fucata Lindl. [Nariño]

Lantana glutinosa Poepp. [Arauca, Chocó, Huila, & Santander]

Lantana lopez-palacii Moldenke [Norte de Santander & Tolima]

Lantana macrophylla var. grosseserrata Moldenke [Antioquia & Tolima]

Lantana rugulosa var. parvipedunculata Moldenke [Boyaca, Cauca, Nariño, & Tolima]

Lantana tomasii Moldenke — to be deleted
Lantana trifolia f. hirsuta Moldenke [Arauca]
Lippia alba (Mill.) N. E. Br. [Meta]
Lippia americana L. [Meta]
Lippia americana f. pilosa Moldenke [Santander]
Lippia origanoides H.B.K. [Cauca]
Paepalanthus andicola Körn. [Boyacá]
Paepalanthus karstenii var. corei Moldenke [Boyacá]
Paepalanthus karstenii var. subsessilis (Moldenke) Moldenke [Boyacá, Cundinamarca, & Meta]
Paepalanthus lodiculoides var. floccosus Moldenke [Boyacá & Cundinamarca]*
Paepalanthus subsessilis Moldenke — to be deleted
Petrea riparia Moldenke [Santander]
Petrea rugosa H.B.K. [Córdoba]
Petrea rugosa var. casta Moldenke [Cauca & Valle del Cauca]
Priva lappulacea (L.) Pers. [Arauca]
Priva lappulacea f. albiflora Moldenke [Cundinamarca]
Stachytarpheta cayennensis (L. C. Rich.) Vahl [Arauca & Córdoba]
Stachytarpheta dichotoma (Ruíz & Pav.) Vahl [Amazonas, Arauca, & Valle del Cauca]
Stachytarpheta mutabilis (Jacq.) Vahl [Arauca]
Syngonanthus caulescens (Poir.) Ruhl. [Boyacá]
Syngonanthus macrocaulon Ruhl. [Vaupés]
Syngonanthus oblongus (Körn.) Ruhl. [Vaupés]
Tectona grandis f. punctata Moldenke [Córdoba]
Verbena litoralis H.B.K. [Arauca]
Vitex cymosa Bert. [Caldas]
Vitex orinocensis H.B.K. [Meta]
Vitex orinocensis var. multiflora (Miq.) Huber [Córdoba]

VENEZUELA:

Aegiphila filipes Mart. & Schau. [Lara]
Aegiphila laeta H.B.K. [Barinas]
Avicennia germinans var. cumanensis (H.B.K.) Moldenke [Miranda]
Avicennia germinans var. guayaquilensis (H.B.K.) Moldenke [Miranda]
Citharexylum mirifolium Moldenke [delete "Falcón"]
Clerodendrum philippinum Schau. [Mérida]
Clerodendrum wallichii Merr. [Mérida]
Duranta repens L. [Táchira]
Eriocaulon melanocephalum Kunth [Amazonas]
Lantana camara var. rubra Mosty [Miranda]
Lantana fucata Lindl. [Yaracuy]
Lantana trifolia f. hirsuta Moldenke [Barinas]
Leiothrix umbratilis var. brevipes Moldenke [Bolívar]*
Paepalanthus karstenii var. subsessilis (Moldenke) Moldenke

[Lara & Mérida]
Paepalanthus muscosus Körn. — to be deleted
Paepalanthus subsessilis Moldenke — to be deleted
Petrea arborea H.B.K. [Zulia]
Petrea kohautiana Presl [Aragua]
Petrea pubescens Turcz. [Trujillo]
Philodice hoffmannseggii Mart. [Delta Amacuro & Zulia; delete "Falcón"]
Syngonanthus comosus Alv. Silv. [Amazonas]
Syngonanthus fertilis (Körn.) Ruhl. — to be deleted
Syngonanthus leprieuri (Körn.) Ruhl. [Bolívar]
Vitex orinocensis H.B.K. — delete the asterisk
Vitex orinocensis var. multiflora (Miq.) Huber [Táchira]

GUYANA:
Lantana camara var. splendens (Medic.) Moldenke

SURINAM:
Lantana camara var. moritziana (Otto & Dietr.) López-Palacios
Syngonanthus fertilis (Körn.) Ruhl. — to be deleted
Syngonanthus humboldtii (Kunth) Ruhl.
Syngonanthus longipes Gleason

FRENCH GUIANA:
Syngonanthus leprieuri (Körn.) Ruhl. — delete the asterisk
Vitex stahelii Moldenke

ECUADOR:
Aegiphila alba Moldenke [Morona Santiago]
Aegiphila sellowiana Cham. [Morona Santiago]
Citharexylum lojense Moldenke [Loja]*
Citharexylum poeppigii Walp. [Los Ríos]
Verbena brasiliensis Vell. [Tunguragua]
Verbena demissa Moldenke [Chimborazo]
Verbena parvula var. gigas Moldenke [Pichincha]
Vitex gigantea H.B.K. [Morona Santiago]
Vitex moronensis Moldenke [Morona Santiago]*
Vitex orinocensis var. multiflora (Miq.) Huber [Morona Santiago]
Vitex schunkei Moldenke [Morona Santiago]

GALAPAGOS ISLANDS:
Verbena brasiliensis Vell. [Chatham]

PERU:
Aegiphila cordata var. villosissima (Moldenke) Moldenke [Huánuco]
Lantana rugulosa var. parvipedunculata Moldenke — delete the asterisk]
Lantana svensonii f. albiflora Moldenke [San Martín]
Lippia alba (Mill.) N. E. Br. [Padre Island]
Petrea martiana var. glabrescens Moldenke [Loreto & San Martín]
Phyla strigulosa (Mart. & Gal.) Moldenke [Tumbes]

Syngonanthus nitens (Bong.) Ruhl. [Amazonas]
Verbena occulta Moldenke [Arequipa]
Verbena parvula var. gigas Moldenke -- delete the asterisk
Vitex schunkei Moldenke -- delete the asterisk

BRAZIL:
Aegiphila australis Moldenke [Rio Grande do Sul]
Aloysia schulziana Moldenke [Rio Grande do Sul]
Bouchea pseudochascanum (Walp.) Grenz. [Maranhão]
Clerodendrum inerme (L.) Gaertn. [Guanabara]
Clerodendrum ulei Moldenke [Acre]
Lantana armata var. velutina Moldenke [Minas Gerais, Pernambuco, & São Paulo]
Lantana balansae Briq. [Paraná]
Lantana camara L. [Espirito Santo]
Lantana camara var. moritziana (Otto & Dietr.) López-Palacios [Bahia]
Lantana camara var. splendens (Medic.) Moldenke [Minas Gerais & Rio de Janeiro]
Lantana eitenorum Moldenke [Goiás]*
Lantana hassleri Briq. [Rio Grande do Sul]
Lantana hypoleuca f. albiflora Moldenke [São Paulo]
Lantana iodophylla Schau. [Rio Grande do Sul]
Lantana macrophylla var. grosseserrata Moldenke -- delete the asterisk
Lantana micrantha f. eitenorum Moldenke [São Paulo]*
Lantana pohliana Schau. [Goiás]
Lantana tiliaefolia Cham. [Espirito Santo]
Lantana triplinervia Turcz. [Guanabara]
Leiothrix dielsii var. vilavelhensis Moldenke [Espirito Santo]*
Leiothrix hirsuta (Wikstr.) Ruhl. [Espirito Santo]
Lippia acutidens Mart. & Schau. [Bahia]
Lippia bradeana Moldenke [Minas Gerais]*
Lippia bradeana var. velutina Moldenke*
Lippia francensis Moldenke [Goiás & Minas Gerais]
Lippia gracilis Schau. [Espirito Santo]
Lippia insignis Moldenke [Bahia]*
Lippia morongii Kuntze [Paraná]
Lippia possensis Moldenke [Goiás]*
Lippia primulina S. Moore [Goiás]
Paepalanthus coutoënsis Moldenke [Paraná]
Paepalanthus erectifolius Alv. Silv. [Goiás & Mato Grosso]
Paepalanthus fasciculatus f. sphaerocephalus Herzog [Goiás]
Paepalanthus fasciculifer var. capillifolius Moldenke [Goiás]*
Paepalanthus filifolius Moldenke [Minas Gerais]*
Paepalanthus flaccidus (Bong.) Kunth [Mato Grosso]
Paepalanthus hilairei var. maximiliani Ruhl. [Distrito Federal]

Paepalanthus microcaulon Ruhl. [Minas Gerais]
Paepalanthus pullus Körn. [Espirito Santo]
Paepalanthus schuechianus Körn. [Rio de Janeiro]
Paepalanthus sphaerocephalus Ruhl. [Goiás]
Paepalanthus tortilis var. minor Moldenke [Espirito Santo]*
Petrea martiana var. glabrescens Moldenke [Pará]
Petrea riparia Moldenke — delete the asterisk
Stachytarpheta angustifolia (Mill.) Vahl [Maranhão]
Stachytarpheta angustifolia var. elatior (Schrad.) Lopez-Palacios [São Paulo]
Stachytarpheta candida f. lilacina Moldenke [Goiás]*
Stachytarpheta canescens H.B.K. [Goiás]
Stachytarpheta cayennensis f. albiflora Moldenke [Maranhão]
Stachytarpheta lythrophylla Schau. [Goiás]
Stachytarpheta restingensis Moldenke [Guanabara]
Stachytarpheta villosa Cham. [Goiás]
Syngonanthus anthemiflorus var. subglabrescens Moldenke [Minas Gerais]*
Syngonanthus caespitosus (Wikstr.) Ruhl. [Minas Gerais]
Syngonanthus caulescens var. bellohorizontinus Alv. Silv. [Goiás]
Syngonanthus caulescens f. longipes Moldenke [Distrito Federal]*
Syngonanthus caulescens var. procerus (Klotzsch) Moldenke [Distrito Federal]
Syngonanthus comosus Alv. Silv. — delete the asterisk
Syngonanthus curralensis Moldenke [Bahia]*
Syngonanthus decorus Moldenke [Goiás]*
Syngonanthus eburneus (Körn.) Ruhl. [Mato Grosso]
Syngonanthus glandulosus Gleason [delete "Goiás", "Minas Gerais", & "Piauí"]
Syngonanthus gracilis var. amazonicus Ruhl. [Minas Gerais & Rio de Janeiro]
Syngonanthus huberi Ruhl. [Mato Grosso]
Syngonanthus huberi f. viviparus Moldenke [Mato Grosso]*
Syngonanthus leprieuri (Körn.) Ruhl. [Pará]
Syngonanthus nitens (Bong.) Ruhl. [Piauí]
Syngonanthus prolifer Alv. Silv. [Bahia]
Syngonanthus tenuis (H.B.K.) Ruhl. [Minas Gerais]
Syngonanthus xeranthemoides var. confusus (Körn.) Moldenke [Mato Grosso]
Verbena bonariensis var. hispida Moldenke [Rio Grande do Sul]*
Verbena hirta var. dusenii Moldenke [Paraná & Santa Catarina]*
Verbena laciniata (L.) Briq. [Paraná]
Verbena spectabilis Moldenke [Rio Grande do Sul]
Vitex compressa Turcz. [Roraima]

MARACA ISLAND:

Syngonanthus bulbifer (Huber) Ruhl. — to be deleted

Syngonanthus tenuis (H.B.K.) Ruhl.

BOLIVIA:

Duranta repens var. canescens Moldenke
Duranta sprucei Briq. [La Paz]
Duranta tomentosa Hayek — to be deleted
Syngonanthus gracilis var. aureus Ruh. — to be deleted
Verbena tenuisecta Briq. [Sucre]

PARAGUAY:

Lantana camara var. aculeata (L.) Moldenke
Syngonanthus nitens (Bong.) Ruhl. — to be deleted
Verbena rigida f. paraguayensis Moldenke*

CHILE:

Lantana tiliaefolia Cham. [Tacna]
Rhaphithamnus spinosus var. inermis Kunkel [Osorno]
Verbena araucana R. A. Phil. — delete the asterisk
Verbena bonariensis L. [Arauco]
Verbena brasiliensis Vell. [Cautín]
Verbena chilensis Moldenke [Valdivia]
Verbena corymbosa Ruíz & Pav. [La Laxa Island]
Verbena laciniata (L.) Briq. [Malleco]

MOCHA ISLAND:

Rhaphithamnus spinosus var. inermis Kunkel — delete the asterisk

ARGENTINA:

Eriocaulon sellowianum var. longifolium Moldenke [Corrientes]
Lantana bruchii (Moldenke) Troncoso [Córdoba]*
Lantana camara var. moritziana (Otto & Dietr.) López-Palacios [Corrientes]
Lippia ekmani Moldenke [Corrientes]
Verbena araucana R. A. Phil. [Neuquen]
Verbena chilensis Moldenke — delete the asterisk
Verbena litoralis H.B.K. [San Juan]
Verbena sessilis (Cham.) Kuntze [Entre Ríos]
Verbena spectabilis Moldenke — delete the asterisk

MACARONESIA:

Lantana camara var. aculeata (L.) Moldenke [Horta & Terceira]

GERMANY:

Verbena officinalis var. prostrata Gren. & Godr.
Verbena tenuisecta Briq.

SWITZERLAND:

Clerodendrum bungei Steud.

ETHIOPIA:

Lippia abyssinica var. pubescens (Moldenke) Moldenke

CAPE VERDE ISLANDS:

Verbena officinalis L. [São Jacobi]

LIBERIA:

Clerodendrum triplinerve var. sulcatum (Thomas) Moldenke

TOGOLAND:

Premna quadrifolia var. warneckeana Moldenke*

NIGERIA:

Vitex bakeri B. L. Robinson*

CAMEROONS:

Clerodendrum speciosissimum Van Geert
Clerodendrum umbellatum var. asperifolium (Thomas) Moldenke
Lantana mearnsii var. congolensis Moldenke

ZAIRE:

Lantana camara var. splendens (Medic.) Moldenke

UGANDA:

Lippia abyssinica var. pubescens (Moldenke) Moldenke — delete the asterisk

TANGANYIKA:

Clerodendrum incisum var. macrosiphon (Hook. f.) J. G. Baker
Premna richardsii Moldenke*
Stachytarpheta jamaicensis (L.) Vahl
Stachytarpheta urticaefolia (Salisb.) Sims
Vitex ferruginea Schum. & Thonn.
Vitex oxycuspis var. mossambicensis Moldenke

KENYA:

Clerodendrum discolor var. pluriflorum Gürke
Lantana camara var. moritziana (Otto & Dietr.) López-Palacios

ANGOLA:

Lantana angolensis Moldenke — delete the asterisk

ZAMBIA:

Clerodendrum discolor var. oppositifolium Thomas
Priva cordifolia var. flabelliformis Moldenke
Verbena officinalis var. natalensis Hochst.

RHODESIA:

Clerodendrum cuneatum Gürke
Clerodendrum discolor var. pluriflorum Gürke
Clerodendrum ternatum f. glabricalyx Moldenke
Lantana rhodesiensis Moldenke
Premna senensis Klotzsch
Verbena officinalis var. natalensis Hochst.

MOZAMBIQUE:

Avicennia marina (Forsk.) Vierh. [Manica e Sofala & Zambezia]
Vitex oyxcuspis var. mossambicensis Moldenke — delete the asterisk

NAMIBIA:

Chascanum incisum (H. H. W. Pearson) Moldenke
Clerodendrum glabrum E. Mey.
Clerodendrum pusillum Gürke
Lantana angolensis Moldenke
Lantana rhodesiensis Moldenke
Lippia rehmanni H. H. W. Pearson

Premna senensis Klotzsch
Vitex mombassae Vatke

SOUTH AFRICA:
Chascanum incisum (H. H. W. Pearson) Moldenke [Cape Province] — delete the asterisk
Clerodendrum cuneatum Gürke — delete the asterisk
Clerodendrum discolor var. oppositifolium Thomas [Natal]
Clerodendrum ternatum f. glabricalyx Moldenke [Transvaal]
Clerodendrum triphyllum f. angustissimum Moldenke [Natal & Transvaal]*
Kalaharia uncinata f. rubra Moldenke [Bechuanaland]
Lantana mearnsii var. congolensis Moldenke [Transvaal]
Lantana rhodesiensis Moldenke [Bechuanaland & Transvaal]
Priva cordifolia var. australis Moldenke [Natal]
Verbena officinalis var. gaudichaudii Briq. -- to be deleted
Verbena officinalis var. natalensis Hochst. [Cape Province, Orange Free State, & Transvaal]

MADAGASCAR:
Moldenkeanthus bosseri P. Morat*
Moldenkeanthus itremensis P. Morat*

COMORO ISLANDS:
Lantana trifolia f. hirsuta Moldenke [Mayotte]
Stachytarpheta jamaicensis (L.) Vahl [Aldabra]

SEYCHELLES ISLANDS:
Clerodendrum philippinum f. subfertile Moldenke [Mahé]

MASCARENE ISLANDS:
Eriocaulon "quinquangulare" Bojer*
Premna obtusifolia R. Br. [Ile aux Aigrettes]

ARABIA:
Premna resinosa (Hochst.) Schau. [Yemen]

RÉUNION:
Tectona grandis f. tomentella Moldenke

IRAN:
Avicennia marina var. acutissima Staof & Moldenke

PAKISTAN:
Clerodendrum viscosum Vent. [Northwestern Provinces]
Premna barbata Wall. [Northwestern Provinces]

INDIA:
Avicennia alba Blume [Andhra Pradesh]
Avicennia marina (Forsk.) Vierh. [Mysore; delete "Manauli" & "New & West Islands"]
Avicennia marina var. acutissima Stapf & Moldenke
Avicennia officinalis L. [delete "Krusadi" island]
Callicarpa brevipetiolata Merr. — to be deleted
Clerodendrum inerme (L.) Gaertn. [Kutch, Orissa, Saurashtra, & Tamil Nadu; delete "Krusadi, Manauli, & New islands"]
Clerodendrum inerme f. parvifolium Moldenke [Kerala & Madras]

Clerodendrum serratum var. dentatum H. J. Lam [Kerala]
Eriocaulon collinum Hook. f. [Tamil Nadu]
Eriocaulon echinulatum Mart.
Eriocaulon ensiforme C. E. C. Fischer [Tamil Nadu]
Eriocaulon fluviatile Trimen [Maharashtra]
Eriocaulon quinquangulare L. [Maharashtra]
Eriocaulon thwaitesii Körn. [Maharashtra]
Eriocaulon xeranthemum Mart. [Maharashtra]
Gmelina arborea var. canescens Haines [Union Territory]
Lantana camara f. parvifolia Moldenke [Mysore]
Lantana camara var. rubra Mosty [West Bengal]
Petrea volubilis var. pubescens Moldenke [West Bengal]
Premna divaricata Wall. [Assam]
Premna foetida Reinw. [Assam]
Premna glaberrima Wight [Assam]
Premna obtusifolia R. Br. [delete "Hare" & "Kusadi" islands]
Premna obtusifolia var. minor (Ridl.) Moldenke [Kerala]
Premna punduana Wall. — delete the asterisk
Premna wightiana Schau. -- delete the asterisk
Tectona grandis f. canescens Moldenke [Jaunsar & Siwalik] — delete the asterisk
Tectona grandis f. pilosula Moldenke
xVerbena hybrida Voss [West Bengal]

SOUTH INDIAN ISLANDS AND CAYS:

Avicennia marina (Forsk.) Vierh. [Krusadi, Manauli, New, & West]
Clerodendrum inerme (L.) Gaertn. [Krusadi, Manauli, & New]
Premna obtusifolia R. Br. [Krusadi & Musal Tivu]
Premna wightiana Schau. [Manauli]

SRI LANKA:

Clerodendrum inerme f. parvifolium Moldenke
Eriocaulon longicuspe var. zeylanicum Moldenke*
Eriocaulon setaceum var. capillus-naiadis (Hook. f.) Moldenke — delete the asterisk
Gmelina asiatica f. lobata Moldenke*
Lantana camara var. splendens (Medic.) Moldenke
xStachytarpheta adulterina Urb. & Ekm.
Tectona grandis var. glabrifolia Moldenke — to be deleted

SRI LANKAN ISLANDS:

Clerodendrum inerme (L.) Gaertn. — to be deleted
Clerodendrum inerme f. parvifolium Moldenke [Mannar]

BURMA:

Clerodendrum viscosum var. helferi Moldenke [Tenasserim]
Eriocaulon setaceum var. capillus-naiadis (Hook. f.) Moldenke [Upper Burma]
Premna calycina Haines [Tenasserim]
Premna macrophylla Wall.

Premna odorata Blanco — to be deleted
Premna tomentosa Willd. [Upper Burma]
Pygmaeopremna herbacea (Roxb.) Moldenke [Upper Burma]

ANDAMAN ISLANDS:
Clerodendrum lankawiense var. andamanense Moldenke [South Andaman]*
Clerodendrum viscosum Vent. [South Andaman]

NICOBAR ISLANDS:
Eriocaulon australe R. Br. [Teressa]

BANGLADESH:
Callicarpa brevipetiolata Merr. — to be deleted
Callicarpa kochiana Mak.
Callicarpa rubella Lindl.
Clerodendrum inerme f. parvifolium Moldenke
Premna pinguis C. B. Clarke
Premna punduana Wall.

CHINA:
Clerodendrum serratum var. amplexifolium Moldenke — delete the asterisk
Eriocaulon henryanum Ruhl. [Fukien]
Eriocaulon henryanum f. viviparum Moldenke [Fukien]*
Eriocaulon nipponicum Maxim. [Fukien]
Eriocaulon truncatum Hamilt. [Kwangsi]
Lantana camara var. splendens (Medic.) Moldenke [Chekiang & Kwangsi]

CHINESE COASTAL ISLANDS:
Sphenodesme floribunda Chin & How [Hainan]*

HONG KONG:
Clerodendrum fortunatum L.
Clerodendrum trichotomum Thunb.
Eriocaulon setaceum var. capillus-naiadis (Hook. f.) Moldenke
Eriocaulon suishaense Hayata
Premna microphylla Turcz.

THAILAND:
Callicarpa brevipetiolata Merr. — to be deleted
Callicarpa macrophylla var. griffithiana C. B. Clarke
Clerodendrum kaempferi f. salmoneum Moldenke*
Clerodendrum serratum var. amplexifolium Moldenke
Clerodendrum viscosum var. helferi Moldenke
Glossocarya siamensis var. pubescens Moldenke*
Lantana camara var. splendens (Medic.) Moldenke
Tectona grandis f. punctata Moldenke
Vitex vestita f. quinquefoliolata Moldenke*

INDOCHINA:
Clerodendrum inerme f. parvifolium Moldenke [Annam]
Eriocaulon achiton Körn. — to be deleted
Eriocaulon boni H. Lecomte [Annam]

Eriocaulon sexangulare L. [Cambodia]
Gmelina elliptica J. E. Sm. [Cambodia]
Premna tomentosa var. pierreana Dop [Tonkin]

MALAYA:

Avicennia alba Blume [Trengganu]
Avicennia alba var. latifolia Moldenke [Selangor & Trengganu]
Avicennia marina var. rumphiana (H. Hallier) Bakh. [Selangor]
Clerodendrum deflexum Wall. [Kelantan, Selangor, & Trengganu]
Clerodendrum deflexum var. villosulum Moldenke [Pahang]*
Clerodendrum hendersonii Moldenke [Pahang]*
Clerodendrum indicum (L.) Kuntze [Pahang]
Clerodendrum inerme (L.) Gaertn. [Johore & Selangor]
Clerodendrum infortunatum L. -- to be deleted
Clerodendrum johorense Moldenke [Johore]*
Clerodendrum laevifolium Blume [Negri Sembilan & Selangor]
Clerodendrum philippinum f. subfertile Moldenke [Selangor]
Clerodendrum serratum (L.) Spreng. [Federal Territory]
Clerodendrum umbellatum var. speciosum (Dombrain) Moldenke [Selangor]
Clerodendrum villosum Blume [Negri Sembilan, Pahang, & Selangor]
Duranta repens L. [Federal Territory]
Eriocaulon australe R. Br. [Perak, Selangor, & Trengganu]
Eriocaulon australe f. proliferum Moldenke [Johore]
Eriocaulon truncatum var. malaccense Hook. f. [Selangor]
Eriocaulon willdenovianum Moldenke [Trengganu]
Eriocaulon willdenovianum f. viviparum Moldenke [Pahang & Trengganu]
Gmelina arborea Roxb. [Selangor]
Gmelina asiatica f. lobata Moldenke [Perak]
Gmelina elliptica J. E. Sm. [Selangor & Trengganu]
Lantana camara L. [Selangor]
Lantana camara var. aculeata (L.) Moldenke [Perak]
Peronema canescens Jack [Pahang]
Premna obtusifolia R. Br. [Trengganu]
Premna obtusifolia f. serratifolia (L.) Moldenke [Trengganu]
Premna odorata Blanco [Trengganu]
Premna pyramidata Wall. [Negri Sembilan & Selangor]
Premna scandens Roxb. [Pahang]
Premna trichostoma Miq. [Selangor]
Stachytarpheta cayennensis (L. C. Rich.) Vahl [Selangor]
Stachytarpheta cayennensis f. albiflora Moldenke [Pahang & Selangor]
Stachytarpheta mutabilis (Jacq.) Vahl [Penang]
Stachytarpheta urticaefolia (Salisb.) Sims [Federal Territory & Kelantan]

Vitex gamosepala var. scortechinii King & Gamble [Kelantan & Selangor]
Vitex longisepala var. longipes Moldenke [Pahang & Selangor]*
Vitex negundo L. [Selangor]
Vitex negundo var. cannabifolia (Sieb. & Zucc.) Hand.-Mazz. [Johore & Perak]
Vitex pinnata L. [Negri Sembilan & Trenggamu]
Vitex pinnata f. glabrescens Moldenke [Selangor]*
Vitex trifolia var. simplicifolia Cham. [Trenggamu]
Vitex trifolia var. simplicifolia f. albiflora (Y. Matsumura) Moldenke [Trenggamu]
Vitex vestita f. millsii (M. R. Henderson) Moldenke [Selangor]

MALAYAN ISLANDS:
Avicennia marina var. rumphiana (H. Hallier) Bakh. [Langkawi]
Callicarpa angustifolia King & Gamble [Langkawi]
Clerodendrum inerme (L.) Gaertn. [Langkawi]
Gmelina elliptica J. E. Sm. [Langkawi & Tioman]
Lantana camara L. [Tioman]
Premna dentatifolia Moldenke [Langkawi]
Premna obtusifolia R. Br. [Tioman]
Stachytarpheta cayennensis (L. C. Rich.) Vahl [Langkawi]
Stachytarpheta jamaicensis (L.) Vahl [Langkawi]
Vitex negundo var. cannabifolia (Sieb. & Zucc.) Hand.-Mazz. [Langkawi]
Vitex siamica F. N. Will. [Timun]
Vitex trifolia var. bicolor (Willd.) Moldenke [Langkawi]

RYUKYU ISLAND ARCHIPELAGO:
Callicarpa dichotoma (Lour.) K. Koch [Ikema]
Lantana camara var. moritziana (Otto & Dietr.) López-Palacios [Okinawa]
Verbena officinalis L. [Yonaguni]
Vitex trifolia var. simplicifolia Cham. [Kutaka]

FORMOSA:
Eriocaulon robustius (Maxim.) Mak.

PHILIPPINE ISLANDS:
Clerodendrum apayoënse Quisumb. [Paragua]
Clerodendrum inerme f. parvifolium Moldenke [Luzon]
Eriocaulon infirmum var. puberulentum (Moldenke) Van Royen [Culión]
Lantana camara var. splendens (Medic.) Moldenke [Luzon]
Tectona grandis f. tomentella Moldenke [Jolo & Mindanao]

MARIANAS ISLANDS:
Callicarpa erioclona var. paucinervia (Merr.) Moldenke [Agrigan, Alamagan, & Anatahan]
Callicarpa lammii Hosokawa [Alamagan]
Clerodendrum inerme (L.) Gaertn. [Pagan]
Premna obtusifolia var. gaudichaudii (Schau.) Moldenke [Agrigan,

Alamagan, Anatahan, Asuncion, Guguan, Medinilla, & Sarigan]
Stachytarpheta jamaicensis (L.) Vahl [Pagan & Saipan]
Tectona grandis f. pilosula Moldenke [Guam]
Tectona grandis f. punctata Moldenke [Guam]
Tectona grandis f. tomentella Moldenke [Guam]
Verbena litoralis H.B.K. [Saipan]
Vitex negundo L. [Maug & Pagan]

PALAU ISLANDS:
Callicarpa erioclona var. paucinervia (Merr.) Moldenke [Garim]
Eriocaulon australe R. Br. [Yap]
Phyla nodiflora (L.) Greene [Palau]

GREATER SUNDA ISLANDS:
Avicennia alba Blume [Sebatik]
Callicarpa brevipetiolata Merr. — add an asterisk
Callicarpa involucrata Merr. [Sarawak]
Clerodendrum calamitosum L. [Sarawak]
Clerodendrum phyllomega var. myrmecophilum (Ridl.) Moldenke [Sarawak]
Clerodendrum quadriloculare (Blanco) Merr. [Sabah]
Eriocaulon australe R. Br. [Sarawak]
Eriocaulon australe f. proliferum Moldenke [Sarawak]
Eriocaulon blumei Körn. [Sarawak]
Eriocaulon infirmum var. puberulentum (Moldenke) Van Royen [Sumatra]
Eriocaulon sollyanum var. sumatranum Van Royen [Sumatra]*
Premna dentatifolia Moldenke — delete the asterisk
Premna oblongifolia Merr. [Sarawak]
Tectona grandis f. pilosula Moldenke [Sabah]
Tectona grandis f. punctata Moldenke [Borneo & Sumatra]
Tectona grandis f. tomentella Moldenke [Sabah]

MOLUCCA ISLANDS:
Tectona grandis f. canescens Moldenke [Amboina]

PHOENIX ISLANDS:
Clerodendrum inerme f. parvifolium Moldenke [Canton]

NEW GUINEA:
Clerodendrum inerme f. parvifolium Moldenke [Papua]
Eriocaulon oreadum Van Royen [Papua]
Stachytarpheta urticaefolia (Salisb.) Sims [Papua]
Vitex glabrata R. Br. [Papua]

NEW GUINEAN ISLANDS:
Avicennia officinalis L. [Daru]
Clerodendrum inerme (L.) Gaertn. [Los Negros]
Premna foetida Reinw. [Los Negros]

BISMARK ARCHIPELAGO:
Geunsia cumingiana (Schau.) Rolfe [Manus]
Vitex cofassus Reinw. [New Ireland]

SOLOMON ISLANDS:

Premna obtusifolia var. gaudichaudii (Schau.) Moldenke [Southeast]

NEW CALEDONIAN ISLANDS:

Clerodendrum inerme f. parvifolium Moldenke [New Caledonia]

AUSTRALIA:

Clerodendrum aculeatum (L.) Schlecht. [Queensland]
Eriocaulon depressum R. Br. [Northern Territory]
Eriocaulon nanum R. Br. [Northern Territory]
Eriocaulon nutans F. Muell. — to be deleted
Eriocaulon willdenovianum Moldenke [New South Wales]
Lantana camara var. splendens (Medic.) Moldenke [Queensland]
Lantana montevidensis (Spreng.) Briq. [New South Wales]
Verbena supina f. erecta Moldenke [South Australia]

GREAT BARRIER REEF:

Avicennia eucalyptifolia Zipp. [Bewick, East Petheridge, Fisher, Pipon, Turtle I, Turtle III, & West Petheridge]
Clerodendrum inerme (L.) Gaertn. [Coombe, Eagle, East Hope, Green, Green Ant, Lizard, Newton, Pipon, Saunders, Three Isles, & Two Isles]
Lantana camara L. [East Hope & Low Isles]
Premna obtusifolia R. Br. [Sand & Turtle]
Premna obtusifolia var. gaudichaudii (Schau.) Moldenke [Lizard]
Stachytarpheta jamaicensis (L.) Vahl [Bewick, Eagle, & Green]
Vitex trifolia var. bicolor (Willd.) Moldenke [East Hope, Green, Green Ant, & West Hope]
Vitex trifolia var. simplicifolia Cham. [Eagle, Fife, Ingram, Morris, Saunders, & Sinclair]
Vitex trifolia var. subtrisecta (Kuntze) Moldenke [Howick, Lizard, Low Wooded, Three Isles, Two Isles, & Turtle]

HAWAIIAN ISLANDS:

Clerodendrum glabrum E. Mey. [Oahu]

SAMOAN ISLANDS:

Clerodendrum philippinum Schau. [Upolu]

COOK ISLANDS:

Lantana camara L. [Oneroa]
Lantana camara var. aculeata (L.) Moldenke [Koromiri, Motutapu, & Taakoka]
Stachytarpheta urticaefolia (Salisb.) Sims [Koromiri]
Vitex trifolia var. bicolor (Willd.) Moldenke [Motutapu]

AUSTRAL ISLANDS:

Vitex trifolia var. simplicifolia f. albiflora (Y. Matsumura) Moldenke — delete the asterisk

CULTIVATED:

Aegiphila hassleri Briq. [Argentina]
Aloysia triphylla (L'Hér.) Britton [Balearic Islands & Paraguay]
Avicennia alba Blume [Java]
Avicennia marina (Forsk.) Vierh. [Java]

Avicennia officinalis L. [Java]
Bouchea nelsonii Grenz. [Germany]
Clerodendrum bungei Steud. [Honduras]
Clerodendrum hastatum (Roxb.) Wall. [Germany]
Clerodendrum indicum (L.) Kuntze [Ruad Island]
Clerodendrum inerme f. *parvifolium* Moldenke [India]
Clerodendrum kaempferi (Jacq.) Sieb. [Honduras]
Clerodendrum minahassae Teijsm. & Binn. [Malaya]
Clerodendrum minahassae var. *brevitubulosum* H. J. Lam [Java]
Clerodendrum philippinum Schau. [Balearic Islands & Honduras]
Clerodendrum sahelangii Koord. [Honduras]
Clerodendrum speciosissimum Van Geert [Guam]
Clerodendrum tomentosum (Vent.) R. Br. [Germany]
Clerodendrum viscosum var. *nilagiricum* H. Hallier [Germany]
Congea griffithiana Munir [Samoan Islands]
Congea velutina Wight [California]
Duranta repens L. [Madagascar]
Duranta serratifolia (Griseb.) Kuntze [Surinam]
Gmelina arborea var. *canescens* Haines [India]
Gmelina arborea var. *glaucescens* C. B. Clarke [Germany]
Gmelina asiatica L. [Honduras]
Gmelina elliptica f. *lobata* (Gaertn.) Moldenke [Germany]
Gmelina leichhardtii (F. Muell.) F. Muell. [Australia]
Lantana achyranthifolia f. *grandifolia* Moldenke [Sweden]
Lantana armata Schau. [Colombia]
x*Lantana callowiana* Monrovia -- to be deleted
Lantana camara L. [Austria & Balearic Islands]
Lantana camara var. *aculeata* (L.) Moldenke [Colombia]
Lantana camara var. *flava* (Medic.) Moldenke [Colombia]
Lantana camara var. *moritziana* (Otto & Dietr.) López-Palacios [France, India, & Uruguay]
Lantana camara var. *mutabilis* (Hook.) L. H. Bailey [Germany]
Lantana camara var. *splendens* (Medic.) Moldenke [Colombia & Uruguay]
Lantana canescens H.B.K. [Germany]
Lantana depressa Small [California & Pakistan]
Lantana fucata var. *antillana* Moldenke [Germany]
Lantana glutinosa Poepp. [Germany]
Lantana involucrata f. *rubella* Moldenke [Germany]
Lantana montevidensis var. *aurea* Mattoon --to be deleted
Lantana radula Sw. [Germany]
Lantana reticulata Pers. [Germany]
Lantana viburnoides (Forsk.) Vahl [Germany]
Lippia abyssinica (Otto & Dietr.) Cuf. [Germany]
Oxera pulchella Labill. [Germany]

Peronema canescens Jack [Malaya]
Petrea arborea H.B.K. [Honduras]
Petrea rugosa var. casta Moldenke -- delete the asterisk
Phyla nodiflora var. canescens (H.B.K.) Moldenke [Balearic Islands]
Premna foetida Reinw. [India]
Stachytarpheta angustifolia f. elatior (Schrad.) López-Palacios [Germany]
Stachytarpheta jamaicensis (L.) Vahl [Germany]
Stachytarpheta mutabilis (Jacq.) Vahl [Germany]
Tectona grandis L. f. [Honduras]
Tectona grandis f. canescens Moldenke [Jamaica & Trinidad]
Tectona grandis f. pilosula Moldenke [Colombia, Cook Islands, Cuba, Dominican Republic, & Guam]
Tectona grandis f. punctata Moldenke [Brazil, Ecuador, Panama, & Sri Lanka]
Tectona grandis f. tomentella Moldenke [Guinea, India, New Guinea, & Puerto Rico]
xVerbena baileyana Moldenke [Germany]
Verbena bipinnatifida Nutt. [Sweden]
Verbena bracteata Lag. & Rodr. [Sweden]
Verbena brasiliensis Vell. [California]
Verbena canadensis (L.) Britton [Austria & Bahama Islands]
Verbena carolina L. [Bahama Islands]
Verbena ciliata var. longidentata Perry [France & Germany]
Verbena gracilis Desf. [Germany]
Verbena halei Small [Missouri]
Verbena hastata L. [Bahama Islands]
xVerbena hybrida Voss [Balearic Islands & Czechoslovakia]
Verbena incisa Hook. [Sweden]
Verbena litoralis H.B.K. [Germany & Venezuela]
Verbena monacensis Moldenke [Colombia]
Verbena peruviana (L.) Britton [Balearic Islands, California, & France]
Verbena platensis Spreng. [Honduras]
xVerbena rydbergii Moldenke [Germany]
Verbena tenuisecta Briq. [Germany]
Vitex agnus-castus L. [Balearic Islands, Honduras, & Kentucky]
Vitex agnus-castus var. diversifolia (Carr.) Schelle [Forida & Missouri]
Vitex agnus-castus f. latifolia (Mill.) Rehd. [Oklahoma & South Carolina]
Vitex gigantea H.B.K. [Honduras]
Vitex parviflora A. L. Juss. [Honduras]
Vitex trifolia L. [Malaya]

Additions and emendations to Part II: An alphabetic list of rejected scientific names proposed in these groups, including misspellings and variations in accredition:

Aegiphila mutisii Moldenke = A. bogotensis (Spreng.) Moldenke
Aegiphilla fluminensis Vell. = Aegiphila fluminensis Vell.
Aegiphyla monstrosa Moldenke = Aegiphila monstrosa Moldenke
Aloysia sellowi Briq. = A. sellowii (Briq.) Moldenke
Aloysia wrightii (A. Gray) Hellen = A. wrightii (A. Gray) Heller
Amasonia campestris Moldenke = A. campestris (Aubl.) Moldenke
Anacardium orientale Jouston = Avicennia officinalis L.
Andraspidopsis Körn. = Syngonanthus Ruhl.
Avicenina L. = Avicennia L.
Avicenina officinalis L. = Avicennia officinalis L.
Avicenna marina Cloudsley-Thomp. = Avicennia marina (Forsk.) Vierh.
Avicennia agallocha Puri = Excoecaria agallocha L., Euphorbiaceae — this is the corrected entry
Avicennia alba Miq. = A. alba Blume
Avicennia marina (Forsk.) Vierk. = A. marina (Forsk.) Vierh.
Avicennia marina var. resinifera (Forst.) Bakh. = A. marina var. resinifera (Forst. f.) Bakh.
Avicennia mucronata Cloudsley-Thomp. = Rhizophora mucronata Lam., Rhizophoraceae
Avicennia officianlis Puri = A. officinalis L.
Avicennia officinalis Kurz = A. alba Blume
Avicennia officinalis (L.) Kurz = A. alba Blume -- this is the corrected entry
Avicennia officinalis Lam. = A. officinalis L.
Avicennia officinalis Miq. = A. eucalyptifolia Zipp.
Avicennia officinalis Watt. = A. alba Blume
Avicennia officinalis β lanceolata Kuntze = A. germinans var. guayaquilensis (H.B.K.) Moldenke — this is the corrected entry
Avicennia officinalis γ ovatifolia Kuntze = A. marina (Forsk.) Vierh.
Avicennia officinalis δ spathulata Kuntze = A. lanata Ridl.
Avicennia officinalis δ spathulata f. glandulosa Kuntze = A. marina var. resinifera (Forst. f.) Bakh.
Avicennia tomentosa Jacq. sensu Schau. = A. schaueriana Stapf & Leechman
Avicennia tomentosa sensu Mayc. = A. schaueriana Stapf & Leechman
Avicennia tomentosa Weigelt = A. germinans (L.) L.

Bouchea hyderobadensis (Rottl.) Walp. = Svensonia hyderobadensis (Walp.) Moldenke
Bouchea insignis López-Palacios = B. inopinata Moldenke
Bouchea prisantia (L.) Kuntze = B. prismatica (L.) Kuntze
Callicarpa americana alba Trelease = C. americana var. lactea F. J. Muller
Callicarpa hitchcockiana Millsp. = C. lancifolia Millsp. — this is the corrected entry
Callicarpa hitchcockii Millsp. = C. lancifolia Millsp.
Callicarpa japonica leucocarpa Trelease = C. japonica f. albibacca Hara
Callicarpa pentandra var. pentandra (Bl.) Bakh. = Geunsia pentandra (Roxb.) Merr.
Callicarpa pentandra f. farinosa (Bl.) Bakh. = Geunsia farinosa Blume
Callicarpa subpubes Hook. & Arn. = C. subpubescens Hook. & Arn.
Camara aculeata f. obtusifolia Kuntze = Lantana montevidensis (Spreng.) Briq.
Camara aculeata β subinermis f. obtusifolia Kuntze = Lantana montevidensis (Spreng.) Briq.
Camara melissae folio, flore flavo Dill. = Lantana camara var. flava (Medic.) Moldenke
Caropteris Trelease = Caryopteris Bunge
Carphocephalus Kunth = Syngonanthus Ruhl.
Carpocephalus Körn. = Syngonanthus Ruhl.
Cartpotepala Morat = Carptotepala Moldenke
Caryopteris incana candida Trelease = C. incana var. candida Schneid.
Castelia cuneato-ovata Cav. = Pitraea cuneato-ovata (Cav.) Caro
Castelia cuneato-ovata Rusby = Pitraea cuneato-ovata (Cav.) Caro
Chascanum cerneum (L.) E. Mey. = C. cernuum (L.) E. Mey.
Chascanum dihiscens Moldenke = C. dehiscens (L. f.) Moldenke
Chascanum gariepense E. Mey. = C. garipense E. Mey.
Chascanum hyderobadensis (Walp.) Moldenke = Svensonia hyderobadensis (Walp.) Moldenke
Chytharexylum Sw. = Citharexylum B. Juss.
Chytharexylum caudatum Sw. = Citharexylum caudatum L.
Citarexylum poeppigii f. anomala Moldenke = Citharexylum venezuelense Moldenke
Citharexylum poeppinni Moldenke = C. poeppigii Walp.
Citharexylum poeppinni f. anomala Moldenke = C. venezuelense Moldenke
Citharexylum pringlei Van Houtte = C. ligustrinum Van Houtte
Clerodendron (L.) R. Br. = Clerodendrum Burm.
Clerodendron dispar Geesink & Santisuk = Clerodendrum disparifolium Blume

Clerodendron guerkeanum Gibbs = Clerodendrum guerkei J. G. Baker
Clerodendron hastatum Wall. = Clerodendrum hastatum (Roxb.) Wall.
Clerodendron heterophyllum Schau. = Clerodendrum heterophyllum (Poir.) R. Br.
Clerodendron inerme Benth. = Clerodendrum inerme (L.) Gaertn.
Clerodendron infortunatum Willd. = Clerodendrum infortunatum L.
Clerodendron jargesii Dode = Clerodendrum trichotomum var. fargesii (Dode) Rehd.
Clerodendron rehmannii var. tenuifolium Merxm. = Clerodendrum glabrum var. vagum (Hiern) Moldenke
Clerodendron thomasii Hort. = Clerodendrum thomsonae Balf. f.
Clerodendron viscosum var. nilagirica H. Hallier = Clerodendrum viscosum var. nilagiricum H. Hallier
Clerodendrum adenophysum Wall. = C. adenophysum H. Hallier
Clerodendrum thompsonae Raf. = C. thomsonae Balf. f.
Clerodendrum viscosum Pers. = C. viscosum Vent.
Clerodendrum yaoundense Gürke = C. triplinerve var. sulcatum (Thomas) Moldenke
Congea azurea var. latifolia Wall. = C. tomentosa Roxb.
Cornutia Plum. ex L. = Cornutia Plum.
Cornutia corymbosa Burm. = Premna obtusifolia R. Br.
Cornutioides L. = Premna obtusifolia R. Br.
Cytharexylum bullatum Moldenke = Citharexylum bullatum Moldenke
Dipterocaly (Cham.) Schau. = Lippia Houst.
Dipterocalyx Cham. & Schlecht. = Lippia Houst.
Dupatya centaurodes (Bong.) Kuntze = Syngonanthus centauroides (Bong.) Ruhl.
Dupatya gracilis ([Bong.] Körn.) Kuntze = Syngonanthus gracilis (Bong.) Ruhl.
Eirocaulon N. E. Br. = Eriocaulon Gron.
Eirocaulon baurii N. E. Br. = Eriocaulon bauri N. E. Br.
Eriocaulaceae (L. C. Rich.) A. Rich. = Eriocaulaceae Lindl.
Eriocaulon culmo decangulari, foliis longis laevibus erectis Walt. = E. decangulare L.
Eriocaulon culmo striato longissimo, foliis ensiformibus brevibus prostratis, capitulo globoso Lam. = E. decangulare L.
Eriocaulon eburneum Mart. = Syngonanthus niveus (Bong.) Ruhl.
Eriocaulon ehrenbergianum Klotzsch ex Koern. = E. ehrenbergianum Klotzsch
Eriocaulon fruncatum Buch.-Ham. = E. truncatum Hamilt.
Eriocaulon kornickianum Van Heurck & Muell.-Arg. = E. körnickianum Van Heurck & Muell.-Arg.
Eriocaulon longifolium Nees & Kunth = E. willdenovianum Moldenke
Eriocaulon natans F. Muell. = E. setaceum L.
Eriocaulon noveboracense, capitulo alba globoso s. Globularia americana statices haud absimilis, cauliculis lana atro-

rubente refertis Pluk. = E. decangulare L.
Eriocaulon mutans F. Muell. = E. setaceum L.
Eriocaulon odoratum Mold. = E. odoratum Dalz.
Eriocaulon sollyanum var. sumatranum Van Royen — to be deleted
Eriocaulon taxa Hocking — printer's error, Eriocaulon Gron.
Eriocaulon texensis Körn. = E. texense Körn.
Eriocaulou johnstoui Lorence = Eriocaulon johnstonii Ruhl.
Eriocaulou longifolium Lorence = Eriocaulon willdenovianum Moldenke
Eriocaulum Hook. f. = Eriocaulon Gron.
Eriocolon quinquangulare L. = Eriocaulon quinquangulare L.
Eriscaulon Wms. = Eriocaulon Gron.
Eriscaulon molinae Wms. = Eriocaulon molinae L. O. Williams
Eueriocolon Baill. = Eueriocaulon Körn.
Faradaya excellens K. Sch. = F. papuana Scheff.
Gimelina Jayas. = Gmelina L.
Gimelina arborea Jayas. = Gmelina arborea Roxb.
Glandularia aubletia α Spach = Verbena canadensis (L.) Britton
Glandularia aubletia β Spach = Verbena canadensis (L.) Britton
Glandularia aurantiaca Speg. = Verbena aurantiaca Speg.
Glandularia nivea Mold. = Verbena nivea Moldenke
Glandularia sulphurea D. Don = Verbena sulphurea D. Don
Globulariae affinis aquatica, caule temui aphyllo gramineo, capitulis albicantibus parvis globosis, foliis paucis humistratis gramineis Gron. = Eriocaulon decangulare L.
Glossocaryum Smitinand = Glossocarya Wall.
Gmelina oleifera Abel — not in these groups
Hymenopyramis brachiata Wall. ex Kurz = H. brachiata Wall.
Lantana acanthifolia Hort. = L. achyranthifolia f. grandifolia Moldenke
Lantana alba Vent. = L. nivea Vent.
Lantana amethystina Hort. = L. camara var. mutabilis (Hook.) L. H. Bailey
Lantana callowiana Monrovia = L. montevidensis (Spreng.) Briq.
Lantana camara var. aurantiaca Kummer = L. camara var. moritziana (Otto & Dietr.) López-Palacios
Lantana camara var. lutea Berhaut = L. camara var. flava (Medic.) Moldenke
Lantana floribunda Urb. & Ekm. = Lippia micromera var. helleri (Britton) Moldenke
Lantana incana Otto & Dietr. = L. reticulata Pers. — this is the corrected entry
Lantana montevidensis var. aurea Mattoon = L. depressa Small
Lantana montevidiensis aurea Mattoon = L. depressa Small
Lantana ovalifolia Britt. = L. ovatifolia Britton
Lantana scabrida Sieber = L. camara L.

Lantana tomasi Moldenke = L. macrophylla var. grosseserrata Moldenke — this is the corrected entry

Lantana tomasii Moldenke = L. macrophylla var. grosseserrata Moldenke

Lantana velutinoides var. bruchii Moldenke = L. bruchii (Moldenke) Troncoso — this is the corrected entry

Lantana verbenoides Richards = L. viburnoides (Forsk.) Vahl

Leiothrix curvifolia var. fimbriata Herzog = Syngonanthus caespitosus (Wikstr.) Ruhl.

Limnoxeranthemum pubescens Salzm. = Syngonanthus gracilis var. hirtellus (Steud.) Ruhl. — this is the corrected entry

Lipea Anon. = Lippia Houst.

Lipia Espinal = Lippia Houst.

Lippia Endl. = Lippia Houst.

Lippia asperifolia asperifolia A. Rich. ex Marthe = L. indica Moldenke — this is the corrected entry

Lippia berlandieri DC. = L. graveolens H.B.K.

Lippia grisebachii Troncoso = Lantana grisebachii Stuck.

Lippia lavecolata Michx. = Phyla lanceolata (Michx.) Greene

Lippia ligustrina var. paraguariensis Briq. = Aloysia gratissima var. paraguariensis (Briq.) Moldenke

Lippia nodiflora (L.) Rich. ex Schauer = Phyla nodiflora (L.) Greene

Lippia nodiflora (L.) R. Schauer = Phyla nodiflora (L.) Greene

Lippia viricifolia Heiner = Aloysia virgata (Ruíz & Pav.) A. L. Juss.

Michelia spinosa, floribus luteis Anon. = Gmelina asiatica L.

Monochilus Fisch. = Monochilus Fisch. & Mey.

Paepalanthus Forst. = Paepalanthus Mart.

Paepalanthus arenarius Gardn. = Syngonanthus arenarius (G. Gardn.) Ruhl.

Paepalanthus brizoides Kunth [in part] = Syngonanthus gracilis var. subinflatus Ruhl. — this is the corrected entry

Paepalanthus caulescens var. b subvar. α Körn. = Syngonanthus caulescens (Poir.) Ruhl.

Paepalanthus caulescens var. b subvar. β Körn. = Syngonanthus caulescens (Poir.) Ruhl.

Paepalanthus caulescens var. b subvar. γ Körn. = Syngonanthus caulescens var. angustifolius Moldenke

Paepalanthus caulescens var. b subvar. δ Körn. = Syngonanthus caulescens (Poir.) Ruhl.

Paepalanthus caulescens var. b subvar. ε Körn. = Syngonanthus caulescens (Poir.) Ruhl.

Paepalanthus caulescens var. b subvar. ζ Körn. = Syngonanthus caulescens (Poir.) Ruhl.

Paepalanthus centauroides (Bong.) Körn. = Syngonanthus centaur-

oides (Bong.) Ruhl.

Paepalanthus chrysanthus (Bong.) Körn. = Syngonanthus chrysanthus (Bong.) Ruhl.

Paepalanthus colombianus Cleef = P. columbianus Ruhl.

Paepalanthus flaccidus var. juniperinus Kunth = P. flaccidus (Bong.) Kunth

Paepalanthus gracilis var. α subvar. α Körn. = Syngonanthus gracilis var. subinflatus Ruhl.

Paepalanthus gracilis var. α var. α Körn. = Syngonanthus gracilis var. subinflatus Ruhl.

Paepalanthus gracilis var. α subvar. β Körn. = Syngonanthus gracilis (Bong.) Ruhl.

Paepalanthus gracilis var. α var. β Körn. = Syngonanthus gracilis (Bong.) Ruhl.

Paepalanthus gracilis var. β subvar. α Körn. = Syngonanthus gracilis var. koernickeanus Ruhl.

Paepalanthus gracilis var. β subvar. β Körn. = Syngonanthus gracilis var. setaceus Ruhl.

Paepalanthus lamprocephalum Mart. = Syngonanthus nitens (Bong.) Ruhl.

Paepalanthus leprieuri Körn. = Syngonanthus leprieuri (Körn.) Ruhl.

Paepalanthus leprieurii Körn. = Syngonanthus leprieuri (Körn.) Ruhl. — this is the corrected entry

Paepalanthus schenkii Pouls. = P. schenckii V. A. Pouls.

Paepalanthus speciosus var. tomentosus Alv. Silv. = P. polyanthus var. tomentosus Alv. Silv.

Paepalanthus splendens (Bong.) Mart. = Syngonanthus caulescens (Poir.) Ruhl.

Paepalanthus subsessilis Moldenke = P. karstenii var. subsessilis (Moldenke) Moldenke

Paepalanthus (Andraspidopsis) helminthorrhizus Körn. = Syngonanthus helminthorrhizus (Mart.) Ruhl.

Petatia Dod & Fortuna = Petitia Jacq.

Petatia domingensis Jacq. = Petitia domingensis Jacq.

Philodyce Steud. = Philodice Mart.

Phyla nodiflora var. longiflora Moldenke = P. nodiflora var. longifolia Moldenke

Phyla reptans Auct. = P. strigulosa (Mart. & Gal.) Moldenke

Phyla strigulosa var. strigulosa Thomas = P. strigulosa (Mart. & Gal.) Moldenke

Phylodoce Mart. = Philodice Mart.

Prema Fosberg = Premna L.

Prema obtusifolia Fosberg = Premna obtusifolia R. Br.

Premna bipindensis Gürke = P. quadrifolia Schum. & Thonn.

Premna coriaceae Clarke = P. coriacea C. B. Clarke

Premna flavescens Ham. ex C. B. Cl. = P. flavescens Hamilt.

Premna integrifolia Willd. = P. obtusifolia R. Br.
Premna serrata Hort. = P. esculenta Roxb.
Premna warneckeana Gürke = P. quadrifolia var. warneckeana Moldenke
Priva fischeriana Zucc. = Stachytarpheta urticaefolia (Salisb.) Sims
Priva nodiflora (L.) Greene = Phyla nodiflora (L.) Greene
Psilocephalus Körn. = Syngonanthus Ruhl.
Randiala Petiv. = Eriocaulon Gron.
Randiala americana procerior Petiv. = Eriocaulon decangulare L.
Randiala malabarica, capillaceo folio Petiv. = Eriocaulon setaceum L.
Rononanthus Steyerm. = Rondonanthus Herzog
Sarcostachya Juss. = Stachytarpheta Vahl
Sphenodesme ornata Fletch. = S. involucrata (Presl) B. L. Robinson
Stachytarpheta mutabilis x S. jamaicensis Lam & Brink = xS. adulterina Urb. & Ekm.
Syngonanthus aciphyllus Ruhl. = S. aciphyllus (Bong.) Ruhl.
Syngonanthus albopulvinatus Moldenke = S. albopulvinatus (Moldenke) Moldenke
Syngonanthus androsaceus Ruhl. = S. androsaceus (Griseb.) Ruhl.
Syngonanthus anomalus Ruhl. = S. anomalus (Körn.) Ruhl.
Syngonanthus argenteus Benth. = Eriocaulon ceylanicum Körn.
Syngonanthus caluescens (Bong.) Ruhl. = S. caulescens (Poir.) Ruhl.
Syngonanthus capillifolius Moldenke = Paepalanthus capillifolius Moldenke
Syngonanthus cipoensis Alv. Silv. = S. cipoensis Ruhl. — this is the corrected entry
Syngonanthus cipoënsis Alv. Silv. = S. cipoensis Ruhl.
Syngonanthus diamantinus A. Silveira = S. diamantinensis Alv. Silv.
Syngonanthus dupatya Mart. = S. flavidulus (Michx.) Ruhl.
Syngonanthus gracilis (Bong.) Rühl = S. gracilis (Bong.) Ruhl.
Syngonanthus gracilis var. olivaceus Ruhl. = S. gracilis (Bong.) Ruhl.
Syngonanthus grão-mogolensis Alv. Silv. = S. grao-mogolensis Alv. Silv. — this is the corrected entry
Syngonanthus grão-mogolensis var. detonsus Moldenke = S. grao-mogolensis var. detonsus Moldenke — this is the corrected entry
Syngonanthus grao-nogolensis Alv. Silv. = S. grao-mogolensis Alv. Silv. — this is the corrected entry
Syngonanthus humboldtii var. glandulousus Gleason = S. humboldtii var. glandulosus Gleason
Syngonanthus itambeënsis Alv. Silv. = S. itambeensis Alv. Silv.
Syngonanthus leprieurii (Körn.) Ruhl. = S. leprieuri (Körn.) Ruhl.

Syngonanthus luxurians (Körn.) Ruhl. = Leiothrix luxurians (Körn.) Ruhl.

Syngonanthus nigroalbus A. Silveira = S. nigro-albus Alv. Silv.

Syngonanthus nitens Kunth = S. nitens (Bong.) Ruhl.

Syngonanthus poggeanus Ruhl. x S. angolensis H. Hess = xS. hessii Moldenke

Syngonanthus wahlbergii (Wikstr.) Ruhl. x S. angolensis H. Hess = xS. hybridus Moldenke

Tamone Schnitzlein = Ghinia Schreb.

Tetraclea coulteri var. coulteri Thomas = T. coulteri A. Gray

Thysanocephalus Ruhl. = Thysanocephalus Körn.

Trepanocarpus Mart. = Avicennia L.

Trepanocarpus inundatus Mart. = Avicennia elliptica Holm

Tsjeru-cotsjiletti-pullu Rheede = Eriocaulon setaceum L.

Verbena allata Hort. = V. alata Sweet

Verbena americana frutescens, teucrii foliis & facie, floribus caeruleo-purpurascentibus amplissimis Breyn. = Stachytarpheta mutabilis var. violacea Moldenke

Verbena americana frutescens, teucrii foliis, floribus coeruleo-purpurascentibus amplissimis Breyn. = Stachytarpheta mutabilis var. violacea Moldenke

Verbena andrieuxii DC. = V. andrieuxii Schau.

Verbena arenaria Hügel = V. incisa Hook.

Verbena arenariana Kummer = V. incisa Hook.

Verbena atriota Pabst = V. litoralis H.B.K.

Verbena bipinnatifida var. bipinnatifida Thomas = V. bipinnatifida Nutt.

Verbena bonariensis Hook. = V. bonariensis L.

Verbena bonariensis Willd. = V. bonariensis L.

Verbena bracteata (Michx.) Lag. & Rodr. = V. bracteata Lag. & Rodr.

Verbena canescens var. canescens Thomas = V. canescens H.B.K.

Verbena carascana H.B.K. = V. litoralis var. caracasana (H.B.K.) Moldenke

Verbena carolina var. polystachya (H.B.K.) Schimpff = V. carolina L.

Verbena carolineana El-Gazzar = V. carolina L.

Verbena ciliata var. alba Palmer = V. gooddingii Briq.

Verbena connatibracteata Gill. & Hook. = Junellia connatibracteata (Kuntze) Moldenke

Verbena decemloba Mart. = V. phlogiflora Cham.

Verbena diandra, spicis laxis, calycibus alternis prismaticis truncatis aristatis, foliis ovatis obtusis L. = Bouchea prismatica (L.) Kuntze

Verbena ellipticifolia α acuta Stokes = Stachytarpheta indica (L.) Vahl

Verbena ellipticifolia β obtusa Stokes = Stachytarpheta jamaicensis (L.) Vahl
Verbena genii Hort. = xV. hybrida Voss
Verbena halei Small x V. xutha Lehm. = xV. alleni Moldenke
Verbena hastata var. paniculata Lam. = V. hastata L.
Verbena hybrida var. striata Hort. = xV. hybrida Voss
Verbena inamoma Briq. = V. inamoena Briq.
Verbena laciniosa Schwaegr. = V. hastata L.
Verbena lamberti B.M. = V. canadensis (L.) Britton
Verbena lilacina Harrison = V. rigida var. lilacina (Benary & Bodger) Moldenke
Verbena maritima Sm. = V. maritima Small
Verbena matthessii Turcz. = V. xutha Lehm.
Verbena multicaulis Raf. = V. simplex var. eggerti Moldenke
Verbena mysoorensis R. Wight = Svensonia hyderobadensis (Walp.) Moldenke
Verbena mysuriensis R. Wight = Svensonia hyderobadensis (Walp.) Moldenke
Verbena neomexicana var. neomexicana Thomas = V. neomexicana (A. Gray) Small
Verbena officinalis var. natalensis Hochst. -- to be deleted
Verbena paniculata L. = V. hastata L.
Verbena x perrianna Perkins, Esters, & Tharp = xV. perriana Moldenke
Verbena pinnatifida Ph. = V. hastata L.
Verbena pulchella erinoides Zucc. = V. canadensis (L.) Britton
Verbena pumila Rydb. in Small = V. pumila Rydb.
Verbena rigida var. glandulos Moldenke = V. rigida var. glandulosa Moldenke
Verbena, scutellariae s. cassidae folio, dispermos mericana Pluk. = Bouchea prismatica (L.) Kuntze
Verbena stricta x halei Perkins, Estes, & Tharp = xV. goodmani Moldenke
Verbena tenuisectum McReynolds = V. tenuisecta Briq.
Verbena utenisecta Briq. = V. tenuisecta Briq.
Verbena venosa var. aspera Lorenz = V. rigida Spreng.
Verbena virginianum L. = V. xutha Lehm.
Verbena xatha Lehm. = V. xutha Lehm.
Verbena xutha Lehm. x V. halei Small = xV. alleni Moldenke
Verbenella Spach = Verbena [Dorst.] L.
Verbenella chamaedryfolia Juss. = Verbena peruviana (L.) Britton
Verbenella tweediana Hook. = Verbena phlogiflora Cham.
Vitex agnus-castus var. agnus-castus Thomas = V. agnus-castus L.
Vitex bakeri Robinson -- to be deleted
Vitex ineisa Hartwell = V. negundo var. heterophylla (Franch.) Rehd.

Vitex leucopyrus Sohmer = V. leucoxylon L. f.
Vitex leucozylon L. f. = V. leucoxylon L. f.
Vitex melicarpa Janssonius = V. acuminata R. Br.
Vitex negundo var. intermedia (P'ie) Moldenke = V. negundo var. intermedia (P'ei) Moldenke
Vitex paushiniana Mold. = V. panshiniana Moldenke
Vitex trifolia subsp. trifolia Steen. = V. trifolia L.
Vitex trifoliata var. bicolor (Willd.) Mold. = V. trifolia var. bicolor (Willd.) Moldenke
Vitex vestita Griff. = V. vestita Wall.
Volkameria inermis Sessé & Moc. = Clerodendrum ligustrinum (Jacq.) R. Br.
Volkameria, spinis petiolorum rudimentis L. = Clerodendrum aculeatum (L.) Schlecht.
Walnika P. Hermann = Vitex negundo L.
Zapamia Post & Kuntze = Lippia Houst.
Zapania curassavica (L.) Lam. = Ghinia curassavica (L.) Oken — this is the corrected entry
Zapania mutabilis Lam. = Stachytarpheta mutabilis (Jacq.) Vahl
Zapania mutabilis Zuccagni = Stachytarpheta mutabilis var. violacea Moldenke
Zapania odorata Pers. = Lippia javanica (Burm. f.) Spreng. — this is the corrected entry

Additional herbarium acronyms employed by me in various of my publications [in addition to the 299 listed and explained on pages 795—801 of my "Fifth Summary" (1971)] are: Gz = Department of Botany, Faculty of Science, Cairo University at Giza, Giza, Egypt; Hl = Steven R. Hill herbarium, New York, N. Y.; Kh = University of Karachi, Karachi, Pakistan; Kl = University of Malaya, Kuala Lumpur, Malaysia; Ln = Beal-Darlington Herbarium, Michigan State University, East Lansing, Michigan; Lv = Louisiana State University, Baton Rouge, Louisiana; Pd = Sri Lanka Botanical Garden, Peradeniya, Sri Lanka; Rm = Andrew R. Moldenke herbarium, Santa Cruz, California; Sl = San Angelo College, San Angelo, Texas; Te = Arizona State University, Tempe, Arizona; Ts = William Tans herbarium, Madison, Wisconsin; Ub = Universidade de Brasilia, Brasilia, Brazil; Uw = Wisconsin State University, Oshkosh, Wisconsin; and Zu = Botanischer Garten und Institut für Systematische Botanik der Universität, Zurich, Switzerland.

Many botanists will probably take vigorous exception to my policy of listing obvious misspellings as well as variations in spelling and accredition in this list of rejected names. Many will probably say that these names should be ignored and not "dignified" by inclusion in a published list of synonymy — and so they should from local floras and regional manuals, where they would only clutter up the synonymy. However, in an all-inclusive work like the "Fifth Summary", where an attempt is made to account for all names likely to be encountered by future workers in these groups,

it seems to me that they should be included lest in the future they should be encountered in some publication or on some herbarium label and cause confusion. Some listed here are obvious misspellings due to typographic or stenographic errors (such as "Verbena carolineana") and certainly were not intentional; others (like "Paepalanthus colombianus") seem to be deliberate "corrections" of the original spelling. The latter is in line with the unfortunate tendency now in many quarters to change the spelling or orthography of scientific names on the pretext that the original spelling violated some rule of grammar or linguistics (as was some time ago advocated by Post and Kuntze). It now becomes increasingly difficult to determine if a new orthography of a given name is accidental or is intentional. Hence, it seems best to include all in this list, in each case referring the new spelling or accredition to the name and orthography accepted by me in my monographic work on the groups in question. Many variations in spelling appear in published works or on herbarium labels without any accredition. These are by me accredited to the author or authors of the published work or the collector who prepared the label. Doubtless this will in some cases be regarded as a disservice by the author(s) or collector involved who may insist that they did not intend to propose a new spelling, but since the name, when written, was not formally accredited to anyone else, it seems the only logical procedure to follow. Several scores of such "names" have been thus credited to me and are herein duly recorded in spite of the fact that I never intended to propose such a spelling, combination, accredition, or even taxon! It is to be hoped that Salisbury's policy of "correcting" names that were "inappropriate" will not be revived by the correctionists.

An interesting recent example of the harm that misspellings on herbarium labels can cause is seen in the name, "Lantana callowiana". This seems to have first appeared, on a herbarium sheet, as a misspelling of the well-known name, Lantana sellowiana Link & Otto, for the purple- or lavender-flowered trailing or "weeping" lantana which is now more correctly known as L. montevidensis (Spreng.) Briq. The misspelled name was reported to gardeners, repeated again and again, and finally taken up without question by professional horticulturists. It now appears as the accepted name in many nursery seed-lists and catalogues, not only in the U.S.A., but also abroad, and has been taken up, again without question, by the authors of horticultural articles, books, and even encyclopedias! A yellow-flowered form, apparently L. depressa Small, is even now masquerading under the name, L. callowiana var. aurea! All of which seems plainly to emphasize that galley- and page-proofs should be examined and corrected more assiduously and herbarium labels should be prepared more carefully. After all, it has been estimated that at least fifty percent of all identifications of unknown specimens in herbaria are made by simple comparison with labeled material and the name on the old label then transferred to the new one.

NEW NAMES AND TAXA: SOLANACEAE

W. G. D'Arcy
Missouri Botanical Garden

&

R. C. Keating
Southern Illinois University, Edwardsville

Solanum section Croatianum D'Arcy & Keating, sect. nov. Type: S. croatii D'Arcy & Keating. Frutices, indumentum pilorum scutellorum peltatorum ferenti, plerumque aculeis validis brevibus armatis; floribus 5-meris, calyce dentibus sinibus findentibus, corolla profunde lobata, extus tomentosa, staminibus glabris, ovario 4-loculato, interdum supra 2-loculato.

Solanum croatii D'Arcy & Keating, spec. nov. Frutex, indumentum pilorum scutellorum peltatorum ferenti; foliis lanceolatis, subtus pallido-lepidotis supra glabratis, aculeis sparsim armatis; calyce dentibus minutis, mox lobos inaequales 5 mm longos findenti, corolla lavandula, extus stellato-tomentosus, lobos angustos fere imum divisa; staminibus 5, glabris, sursum dehiscentibus; ovario 4-loculato; seminibus lenticularibus, oblongis. Type: Croat 32021 (MO; dupla P). Nomen Thomasi B. Croati, botanici Missourici designatur ad hanc Solanum.

Solanum heinianum D'Arcy & Keating, spec. nov. Frutex, indumentum pilorum scutellorum peltatorum ferenti; foliis spisse brachyblastis portatis, parvis, oblongis, subtus pallido-lepidotis, supra glabratis; calyce lobis parvis, inaequalis oblongo-rotundis, intus viridis; corolla alba, extus tomentosa pilis stellorum; staminibus 5, glabris; ovario basim 4-loculato, supra 2-loculato; acino maturo haud visi. Type: Croat 31213 (MO; dupla P, ADW). Nomen Heino Heine, botanici florae novae-caledoniae designatur ad hanc Solanum.

Statements supporting the new taxa presented here will appear elsewhere.

NEW NAMES AND TAXA: SOLANACEAE

W. G. D'Arcy
Missouri Botanical Garden

Exedeconus miersii (Hook.f.) D'Arcy, comb. nov. Based on *Dictyocalyx miersii* Hook.f., Trans. Linn. Soc. London 20: 203. 1847.

Hunzikeria D'Arcy, gen. nov. Herba interdum suffrutescens, glandulosa-pubescens; foliis parvis; pedicellis brevibus; dentibus calycis brevibus, latis; corolla salverformi, tubo filiformi, limbo lato, sub-regularitur lobato; capsula 2-luculara, seminibus parvis. Type: *Hunzikeria texana* (Torr.) D'Arcy. Nomen Armando T. Hunzikeri Cordovensis, designatur hanc genus.

Hunzikeria texana (Torr.) D'Arcy, comb. nov. Based on *Browallia* (*Leptoglossis*) *texana* Torrey, Mex. Boundary 2(1); 156. 1859. Type: *Wright 535* (NY, not G-DC).

Statements supporting the new taxa presented here will appear elsewhere.

Additions to the Higher Flora of Wake Island
Pacific Plant Studies 30

Harold St. John
(B. P. Bishop Museum, Honolulu)

Wake Island is a dryish atoll in the north Pacific Ocean, recently exploited as an air base. Its flora has been recorded by Fosberg and Sachet (1969).

David Court-Smith of the British Royal Air Force spent a year on Wake, returing in July 1976. While there he took color photos of nearly every higher plant known to be there. The writer identified the species shown in the pictures, and on this basis can record the following additional species.

Adventive Weeds

Bidens pilosa L., var. *minor* (Bl.) Sherff, photo 26.

Tridax procumbens L. Except certain grasses, the commonest plant on the atoll, photo 25.

Cultivated Ornamentals

Asplenium nidus L., photo 71.

Phymatodes Scolopendria (Burm.) Ching, photos 70, 72.

Araucaria sp., photo 51.

Crinum amabile Donn, photo 54.

Crinum asiaticum L., photo 52.

Erythrina variegata Stickm., var. *orientalis* (L.) Merr., photo 64.

Pedilanthus bracteatus (Jacq.) Boiss. in A. DC., photo 60.

Hibiscus tiliaceus L., photo 62.

Opuntia sp., photos 52, 57.

Calotropis gigantea (L.) R. Br. in Ait., photo 66.

Literature Cited

Fosberg, F. R. & M.-H. Sachet, 1969. Wake Island Vegetation and Flora. Atoll Res. Bull. 123: 1-15.

STUDIES IN THE LIABEAE (ASTERACEAE). V.

NEW ANDEAN SPECIES OF *LIABUM*

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An attempt to treat the genus *Liabum* (sensu Robinson and Brettell, 1974) for the *Flora* of Ecuador has resulted in refined concepts of many older species and in the recognition of six previously undescribed species. In view of the erratic identifications and annotations that have been encountered it seems best to provide all new species descriptions and the comments on other Colombian and Peruvian species at this time to make them available to other workers. Comments on other Ecuadorian species will be given elsewhere.

Liabum amplexicaule Poepp. & Endl. of Peru is notable for the distinctly grooved stems, the small disks on the nodes, the narrow leaves with lateral veins near the margins, and the glabrous disk corollas. *Liabum ulei* Hieron. has previously been recognized as a synonym. Actually *L. acuminatum* Rusby of Bolivia and Peru is distinguished from *L. amplexicaule* only by the complete lack of disks on the nodes. *Liabum falcatum* Rusby of Santa Marta in Colombia also is very similar in habit but the distinction suggested by the geography is reenforced by the presence of hairs on the disk corollas. Many broader-leaved specimens with lateral veins remote from the margins have been seen annotated as *L. amplexicaule*. Some of those from Peru seem to be *L. eriocaulon* Poepp. & Endl. which I would hold distinct for the present even though it shares most other characters with *L. amplexicaule*. Other broad-leaved specimens annotated as *L. amplexicaule* from Ecuador and Peru prove to be various of the new species described below.

Liabum asclepiadeum Sch. Bip. of Venezuela and Colombia is notable for the lack of disks on the nodes, the winged petioles, and the upper leaf surface varying from smooth to distinctly papillose. *Liabum caliense* Hieron. and *L. subumbellatum* Rusby have previously been recognized as synonyms. The species has not been seen south of Colombia and material so annotated from Peru is mostly the new species *L. ferreyrii*.

Liabum solidagineum (H.B.K.) Less. of Peru and Bolivia is notable for its nearly terete stems with rather persistent dense tomentum, the leaves shortly trinervate with lateral veins rarely reaching beyond midleaf, and the corolla lobes being nearly smooth. Liabum fulvotomentosum O.Kuntze has been recognized as a synonym and L. acutifolium Cuatr. should be added to the synonymy. Specimens named L. solidagineum from Colombia and Ecuador differ most significantly by the densely spiculiferous tips of the corolla lobes and they seem to represent forms of L. igniarium (H.B.K.) Less.

Liabum nigropilosum Hieron. is an Ecuadorian species of limited distribution. The winged petioles are very distinctive. Liabum stipulatum Rusby of Colombia has been placed in synonymy but the petioles of the latter are unwinged and the species seems thoroughly distinct.

The following new species can be distinguished by numerous features including stem ribbing and pubescence, nodal disks, leaf venation and margin, density of the inflorescence, involucral bracts and geography. In the process of preparing descriptions it was discovered that each can also be identified by details of the disk corollas alone.

Liabum barclayae H.Robinson, sp. nov.

Plantae suffrutescentes terrestres 2-3 m altae laxe ramosae. Caules teretes vel vix sexangulares dense canescentiter tomentelli, nodis disciferis, discis minime 3-4 mm diam. Folia opposita, petiolis ca. 7-10 mm longis non alatis; laminae ovatae 6-10 cm longae et 2-5 cm latae base subrotundatae et anguste acuminatae margine minute approximate serratae apice acutae vel breviter acuminatae supra non pilosae obscuro-virides laeves subtus canescentiter dense tomentellae in nervis solum albo-tomentellis fere ad basem trinervatae, nervis lateralibus valde ascendentibus inferne e marginis remotis superne tenuibus 2/3 laminarum attingentibus. Inflorescentiae terminales cymosae, pedicellis 1-15 mm longis albo-arachnoideo-tomentellis et obscure rubro-pilosis. Capitula 8-9 mm alta ca. 7 mm lata. Squamae involucri 50-55 ca. 5 seriatae 2-6 mm longae lanceolatae vel lineari-lanceolatae margine et plerumque apice purpurascentes apice longe attenuatae extus sparse puberulae et arachnoideo-pubescentes interiores subtiliter carinatae; cristae receptaculorum laciniis longis obsitae. Flores radii ca. 22 27; corollae flavae, tubis 3 mm

longae superne piliferae, limbis 5-6 mm longis anguste ellipticis. Flores disci ca. 25; corollae flavae, tubis ca. 3 mm longis superne sensim latioribus puberulis, faucis indistinctis ca. 1.5 mm longis, lobis 2 mm longis ca. 0.3 mm latis apice sublaevibus; thecae antherarum ca. 2.8 mm longae; appendices oblongae ca. 0.35 mm longae et 0.17 mm latae. Achaenia ca. 1 mm longa dense setifera; setae pappi interiores ca. 25 ca. 4.5-5.5 mm longae exteriores parum latiores ca. 2 mm longae. Grana pollinis ca. 25 μ diam.

TYPE: ECUADOR: Chimborazo: Short distance south of Chunchí on road to Cuenca. Roadside banks with shrubs, land mostly cultivated. Alt. cerca 2700 m. Beautiful herb to 2-3 m tall. Stems and under sides of leaves whitish with fine woolly hairs. Invol. bracts green, woolly with sharp brown tips. Ligul. fls. yellow, narrow; disc fls. yellow; stigmas yellow, very long. July 27, 1959. Harriet G. Barclay & Pedro Juajibioy 8316 (holotype US).

The new species has the more terete stems and short lateral nerves of the leaves that suggests relationship to *Liabum igniarium* and *L. solidagineum*. *Liabum barclayae* differs from these and most other species of the genus by the very elongate involucral bracts. The species occurs within the range of *L. igniarium* from which it differs further by the smooth lobe tips of the disk corollas.

Liabum ferreyrii H.Robinson, sp. nov.

Plantae suffrutescentes subscandentes terrestres 1-2 m altae pauce ramosae. Caules distincte sexangulares sparse arachnoideo-pubescentes, nodis non disciferis solum anguste alatis. Folia opposita, petiolis indistinctis alatis in nodis anguste connatis; laminae late ellipticae raro obovatae 8-14 cm longae et 2.5-7.5 cm latae base cuneatae et acuminatae margine distincte argute saepe remote serratae apice anguste breviter acuminatae supra non pilosae obscuro-virides sublaeves in nervis et saepe nervulis prominulae subtus plerumque lepidote albo-tomentosae in nervis sordidae non pilosae supra basem trinervatae, nervis secundariis intramarginalibus distinctis tenuibus, nervis lateralibus majoribus valde ascendentibus 7/8 longitudinem laminarum attingentibus. Inflorescentiae terminales laxe cymosae, pedicellis 5-35 mm longae albo-arachnoideo-tomentellae et obscure rubro-pilosis. Capitula ca. 8 mm alta et 10 mm lata. Squamae involucri ca. 60 ca. 5-seriatae valde inaequales 1.5-4.0 mm longae ovatae vel lanceolatae apicae acutae et purpurascentes exteriores persistentiter arachnoideo-

tomentellae interiores extus minute puberulae; cristae receptaculorum breviter lobatae. Flores radii ca. 20; corollae flavae, tubis 3 mm longis superne pauce piliferis, limbis ca. 7 mm longis et 1 mm latis extus usque ad medio puberulae. Flores disci ca. 20; corollae flavae tubis 2.0-3.5 mm longis subglabris, faucis 1.2-1.5 mm longis extus sparse puberulis, lobis 1.5 mm longis et 0.4 mm latis apice sublaevibus; thecae antherarum 2 mm longae; appendices oblongo-triangulares 0.3-0.4 mm longae et ca. 0.17 mm latae. Achaenia matura 2.5-3.0 mm longa setifera; setae pappi interiores 40-50 plerumque 6-7 mm longae inferne tenues apice breviter et distincte pauce incrassatae exteriores ca. 1.5 mm longae lineari-lanceolatae. Grana pollinis 25-30 μ diam.

TYPE: PERU: Huánuco: Prov. Huanuco, Carpish, entre Huánuco i Tingo María. Alt. 2700-2800 m. bosque denso siempre verde. Arbusto 1.2-1.5 m. 1 Oct. 1950. Ramón Ferreyra 8074 (holotype US). Paratypes: PERU: Huánuco: Carpish, cumbre entre Huánuco y Tingo María. Alt. 2700-2900 m. Selva subtropical. Arbusto 0.8-1.2 m, flores amarillas. Ferreyra 8152 (US); carretera Huánuco-Tingo María. Alt. 2800-2900 m. Ferreyra 2333 (US); Carpish Pass, 84 km from Tingo María on highway to Lima; alt. about 2750 m. 19 Nov. 1949. H.A.Allard 20982, 21099 (US); Carpish, above Acomayo, rd to Tingo María. Alt. 2800 m. Laxly vining shrub 2 m. on open slopes. Leaves dull green, tannish white beneath. Fls. golden yellow. 17 July 1964. Hutchison, Wright, & Straw 5948 (US).

Liabum ferreyrii is related to *L. asclepiadeum* of Colombia and Venezuela by the winged petioles and lack of discrete expanded disks on the nodes. Among the numerous differences are the generally larger sizes of heads and achenes in the new species, the more remote and more strongly mucronate teeth, the complete lack of papillae on the upper leaf surface, the nearly smooth tips of the disk corolla lobes, and the lack of laciniate chaff on the ridges of the receptacle. The leaves of the new species have a distinctive appearance, tending to be more obovate with the lateral veins usually running parallel to the margins. Particularly marked are the weaker but distinct veins from nearer the base that also run upward along the basal 1/3 - 1/2 of the margin.

Liabum kingii H.Robinson, sp. nov.

Plantae suffrutescentes terrestres 1-2 m altae laxe ramosae. Caules teretes vel vix sexangulares appresse evanescentiter arachnoideo-tomentelli, nodis

disciferis, discis 5-15 mm diam. Folia opposita, petiolis 5-40 mm longis non alatis; laminae ovatae 4-13 cm longae et 2.2-6.0 cm latae base late cuneatae vel subrotundatae et anguste acuminatae margine approximatae argute serratae apice acutae vel breviter acuminatae supra non pilosae obscuro-virides sublaeves nervis et nervulis vix prominulis subtus dense albo-tomentellae in nervis solum albo-tomentellae fere ad basem trinervatae, nervis lateralibus valde ascendentibus inferne ad marginem saepe subparallelis superne subpercurrentibus. Inflorescentiae terminales laxe cymosae, pedicellis plerumque 5-20 mm longis arachnoideo-tomentellis et distincte rubro-pilosis. Capitula ca. 5 mm alta et lata. Squamae involucri 55-70 ca. 5-seriatae 1-4 mm longae anguste oblongae vel anguste lanceolatae exteriores extus sparse arachnoideo-tomentellae apice anguste obtusae purpurascentes interiores extus sparse minute puberulae apice acutae plerumque virides; cristae receptaculorum laciniis longis obsitae. Flores radii ca. 25; corollae flavae, tubis 2.5 mm longis piliferae, limbis ca. 5 mm longis et 1 mm latis anguste ellipticis base piliferis. Flores disci ca. 25; corollae flavae, tubis ca. 2 mm longis piliferis, faucis distinctis ca. 0.5 mm longis plerumque piliferis, lobis ca. 1.8 mm longis ca. 0.2 mm latis apice dense spiculiferis; thecae antherarum ca. 1.7 mm longae; appendices longe triangulares ca. 1.4 mm longae et 0.17 mm latae. Achaenia ca. 1 mm longa dense setifera; setae pappi interiores ca. 25 plerumque 4 mm longae exteriores ca. 1 mm longae indistinctae. Grana pollinis ca. 25 μ diam.

TYPE: ECUADOR: Tungurahua: along the road to Puyo, ca. 2 kms E of Río Negro. Elev. ca. 4300 ft. Common, up to 1 ½ meters tall, open areas, flowers yellow. 21 Jan. 1974. R.M.King 6563 (holotype US). Paratypes: ECUADOR: Tungurahua: Valley of Pastaza River, between Baños and Cashurco, 8 hours east of Baños. Alt. 1300-1800 m. 25 Sept. 1923. A.S.Hitchcock 21843 (US); Along the road to Puyo, ca. 2 kms E of Río Negro. Elev. ca. 4300 ft. Shrub 1 m tall, shaded area, flowers yellow. 21 Jan. 1974. R.M.King 6555 (US); Along the road to Tena, ca. 18 kms N of Puyo. Elev. ca. 3800 ft. Abundant plants, open sun, flowers yellow. 22 Jan. 1974. R.M.King 6568 (US); Roadside approx. 30 km. e. Baños, Pastaza ca. 1300 m. 11 June 1974. J.A.Odom 109 (US); In silv. suband. Aug. 1901. Sodiro 88 (US); 1857-9. R.Spruce 5122 (NY); Pastaza R., alt. 1200 m. Herb. 1 m high. Feb. 1935. A.Rimbach 279 (NY).

Liabum kingii is one of the group with disks on

the nodes and the lateral veins of the leaf reaching nearly to the tip. Of the related species L. vargasii n. sp. of Peru differs by the more grooved and more densely tomentose stems, by the more acuminate leaf tips, the slightly larger heads with greener more acute bracts, more flowers per head, and by the disk corollas with longer glabrous throats and smooth lobe tips. Liabum trianae n. sp. of Colombia differs by the more closely serrate leaves having papillose upper surfaces, heads with more flowers, and the disk corollas with longer glabrous throats. Only L. saloyense Domke of northern Ecuador and southern Colombia seems to have disk corollas with short throats as in L. kingii, but it differs by the more grooved stems, the rather rhomboid leaf blades having papillose upper surfaces, and by the blades being trinervate from the extreme base with the veins brownish pilose beneath.

Liabum macbridei H.Robinson, sp. nov.

Plantae suffrutescentes vel frutescentes terrestres 1-3 m altae pauce ramosae. Caules vix sexangulares vel teretes sparse arachnoideo-pubescentes, nodis disciferis, disci 5-8 mm diam. Folia opposita, petiolis plerumque 1-3 cm longis non alatis; laminae ovatae 6-20 cm longae et 3-11 cm latae base late et distincte acuminatae margine subintegrae dense perminute denticulatae apice distincte breviter acuminatae supra non pilosae laeves obscuro-virides subtus albotomentosae in nervis non pilosae 5-20 mm supra basem trinervatae, nervis lateralibus valde ascendentibus inferne saepe e marginis remotis superne tenuibus solum 2/3-3/4 longitudinem laminarum attingentibus. Inflorescentiae terminales laxae cymosae, pedicellis 5-30 mm longis albo-tomentosis, pilis rubro-septatis subnullis. Capitula 6-7 mm alta et 10-11 mm lata. Squamae involucri 70-90 ca. 5-seriatae valde inaequales 1-5 mm longae lanceolatae vel lineari-lanceolatae apice acutae in squamis exterioribus interdum purpurascentes extus arachnoideo-tomentellae interiores extus puberulae; cristae receptaculorum laciniis longis obsitae. Flores radii ca. 32-33; corollae flavae, tubis 3.0-3.5 mm longis superne dense piliferis, limbis 5-6 mm longis et 1 mm latis glabris. Flores disci 35-40; corollae flavae non piliferae, tubis ca. 3 mm longis glabris, faucis 1.3 mm longis glabris, lobis ca. 1.2 mm longis et 0.2-0.3 mm latis apice dense spiculiferis; thecae antherarum 1.9 mm longae; appendices anguste ovatae ca. 0.30 mm longae et 0.15 mm latae. Achaenia immatura ca. 1 mm longa setifera; setae pappi interiores ca. 25 plerumque 4.0-4.5 mm longae apice interdum vix incrassatae exter-

iores 1.0-1.5 mm longae lineares. Grana pollinis ca. 25 μ diam.

TYPE: PERU: Huánuco: Río Huallaga Cañon, below Río Santo Domingo, about 4000 ft. Open wood. Open, 2-3 ft. high. Deep Yellow. 2 June 1923. F.J.Macbride 4224 (holotype US). Paratype: PERU: Junin: Oreja de Capelo, between Tarma and La Merced, at tunnel entrance thru mt. steep mountain side. Rays yellow, disc dark yellow. Undersurface leaves white. To 1 m tall. 9 Sept. 1972. J.Canne & J.Schunke V. 266 (US).

Liabum macbridei has nearly terete stems with rather persistent tomentum and leaves with short lateral veins indicating relationship to *L. igniarium* of Colombia and Ecuador and *L. solidagineum* of Peru and Bolivia. Both of the related species differ in the tendency for coarser teeth on the leaf margin and more purple involucral bracts. *Liabum igniarium* differs further by the shiny upper leaf surface with prominent veinlets, by the generally larger heads, and by the hairs on the throats of the disk corollas. In *L. igniarium* there is also a tendency for the nodal disks to become very large, a condition not seen in the limited material of the new species. *Liabum solidagineum* is further distinguished by the usually lanceolate leaves which are often shiny above, by the broad involucral bracts, and by the smooth lobe tips of the disk corollas.

Liabum trianae H.Robinson, sp. nov.

Plantae suffrutescentes terrestres ca. 1 m altae pauce ramosae. Caules sexangulares vel subteretes appresse evanescentiter arachnoideo-pubescentes, nodis disciferis, discis 5-10 mm in diam. Folia opposita, petiolis 5-40 mm longis non vel anguste alatis; laminae ovatae vel anguste ovatae 6-13 cm longae et 2-8 cm latae base cuneatae vel late cuneatae et anguste acuminatae margine dense argute serratae apice breviter acuminatae vel breviter acutae supra dense papillosae obscuro-virides subtus albo-tomentosae in nervis non pilosae inferne trinervatae, nervis lateralibus valde ascendentibus inferne interdum e marginis remotis superne percurrentibus. Inflorescentiae terminales laxe cymosae, pedicellis 5-35 mm longis albo-arachnoideo-tomentellae et distincte rubro-pilosae. Capitula 8-10 mm alta et 10-12 mm lata. Squamae involucri ca. 80 in serieibus 5-6 valde inaequales 1-5 mm longae lanceolatae vel lineari-lanceolatae plerumque purpurascentes apice argute acutae extus minute puberulae inferne arachnoideo-tomentellae; cristae receptaculorum laciniis longis obsitae. Flores radii ca. 38-45;

corollae flavae, tubis 3.5-4.0 mm longis piliferis, limbis 7-10 mm longis et 1 mm latis base piliferis. Flores disci ca. 50; corollae flavae, tubis 2.5-4.0 mm longis piliferis, faucis 1.0-1.3 mm longis base piliferis, lobis 1.5-2.0 mm longis et 0.4 mm latis apice dense spiculiferis; thecae antherarum ca. 2 mm longae; appendices 0.4 mm longae et 0.17 mm latae. Achaenia ca. 1 mm longa setifera; setae pappi ca. 30 plerumque 5.0-6.0 mm longae apice vix incrassatae, serieibus exterioribus nullis vel subnullis. Grana pollinis 25-30 μ diam.

TYPE: COLOMBIA: Tolima: Central Cordillera, ca. 23 kms west southwest of Fresno. El. ca. 2350 m, uncommon, shaded areas; flowers orange-yellow. 16-17 July 1965. R.M.King, A.E.Guevara, & E.Forero G. 6006 (holotype US; isotype NY). Paratypes: COLOMBIA: Linden 103 (US); Caldas: Cordillera Central, Salento, edge of forest above Salento, alt. 2100-2500 m, herb, flowers yellow. 25-31 July 1922. F.W.Pennell 8896 (US); Tolima: Mariquita, 1800 m. Triana 1135 (US).

The new species has been collected by a series of collectors starting with Triana. It is in the relationship of L. kingii n. sp. and most of the distinctive characters are given under that species. Liabum trianae is further distinguished from all but L. saloyense by the near lack of a short outer series of setae on the pappus.

Liabum vargasii H.Robinson, sp. nov.

Plantae suffrutescentes 2-3 m altae pauce ramosae. Caules valde sexangulares dense sordido-tomentosi, nodis disciferis, discis 5-14 mm in diam. Folia opposita, petiolis angustis 10-25 mm longis non vel vix alatis; laminae ovatae 7-18 cm longae et 3.5-7.5 cm latae base breviter anguste acuminatae margine argute mucronato-serratae apice anguste longe acuminatae supra laeves non pilosae obscuro-virides subtus albo-tomentosae in nervis fuscescentes fere ad basem trinervatae, nervis lateralibus valde ascendentibus e marginis remotis 4/5 longitudinem laminarum attingentibus. Inflorescentiae terminales laxae, pedicellis plerumque 5-30 mm longis. Capitula 7-8 mm alta et 7-12 mm lata. Squamae involucri 60-80 ca. 5-6-seriatae valde inaequales 1.5-6.0 mm longae exteriores ovato-lanceolatae argute acutae inferne persistentiter arachnoideo-tomentosae interiores lineares anguste acutae extus minute puberulae in medio subcarinatae; cristae receptaculorum lacinis longis obsitae. Flores radii ca. 30-33; corollae flavae, tubis 2.0-3.5 mm longis piliferis, limbis 5-6 mm longis et 1.3 mm latis anguste ellipticis. Flores disci ca. 35-40; corollae

flavae, tubis ca. 2-3 mm longis piliferis, faucis distinctis 1-2 mm longis, lobis ca. 1.5 mm longis et 0.3 mm latis apice subglabris vel pauce spiculiferis; thecae antherarum 2 mm longae; appendices oblongae ca. 0.25 mm longae et ca. 0.1 mm latae. Achaenia ca. 1 mm longa setifera; setae pappi interiores ca. 25 plerumque 4 mm longae apice vix incrassatae exteriores ca. 1 mm longae. Grana pollinis ca. 25 μ diam.

TYPE: PERU: Cuzco: Urubamba, Machupycchu, alt. 2000 m. Arbusto 1 m $\pm$. 28 July 1951. Vargas 10182 (US). Paratypes: PERU: Cuzco: Urubamba, Macchupicchu, alt. 2400 m, selva subtropical baja. Arbusto, flores amarillas. 18 Nov. 1947. R.Ferreyra 2691 (US); Macchu-Picchu, monte perennifolio. Arbusto 2-3 m de alto, flores amarillas. Alt. 2000 m. 8 Aug. 1954. R.Ferreyra 9910 (US).

Liabum vargasii is related to *L. kingii* n. sp. and differences are discussed under that species.

Literature Cited

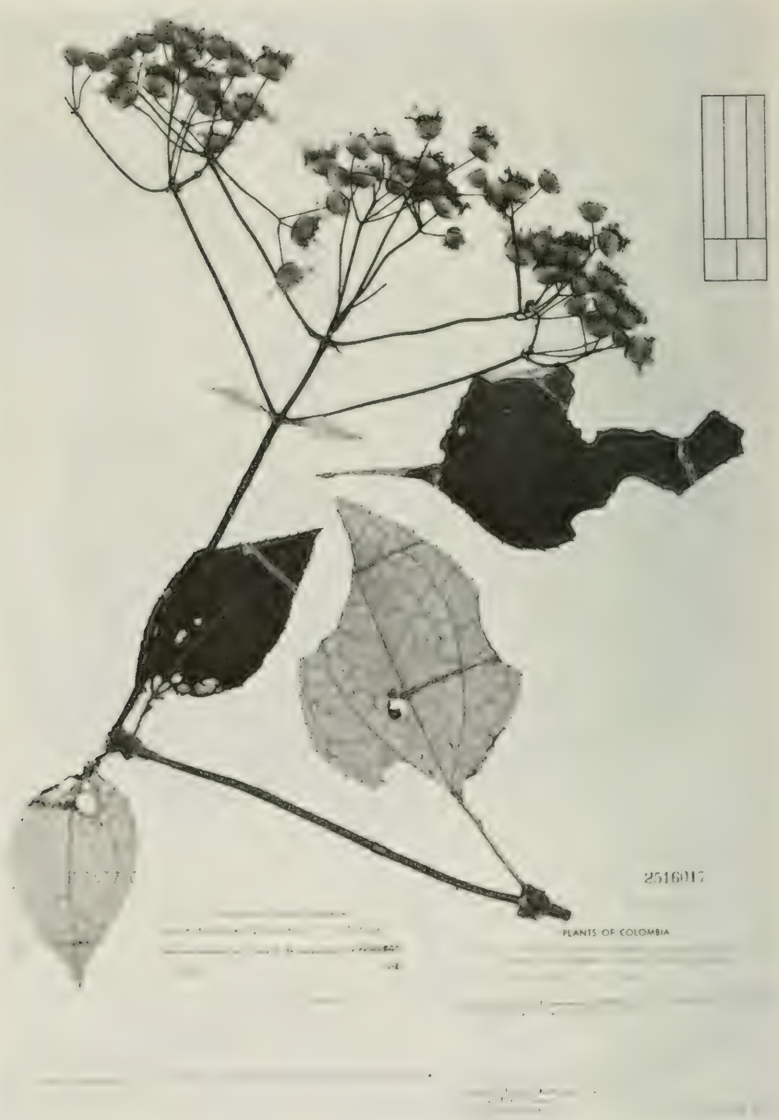
Robinson, H. and R. D. Brettell 1974. Studies in the Liabeae (Asteraceae). II. Preliminary survey of the genera. Phytologia 28 (1): 43-63.

Liabum barclayae H. Robinson, Holotype, United States National Herbarium. Photo by Victor E. Krantz, Staff Photographer, National Museum of Natural History.

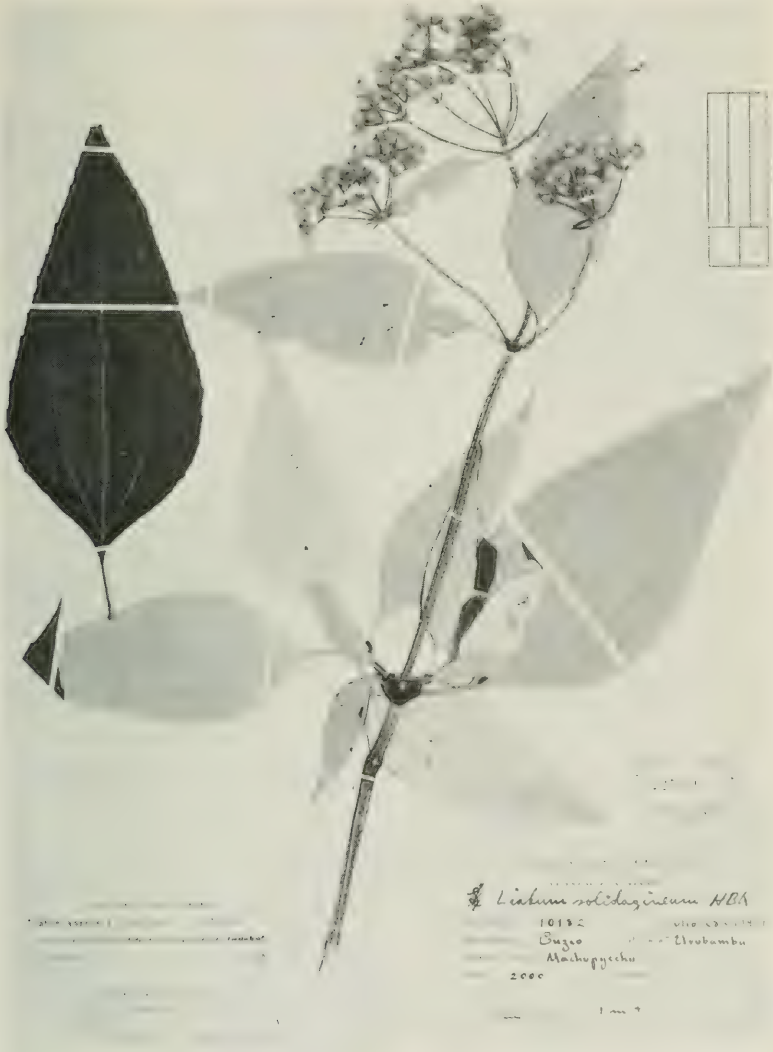
Liabum ferreyrii H. Robinson, Holotype, United States National Herbarium.

Liabum kingii H. Robinson, Holotype, United States National Herbarium.

Liabum macbridei H. Robinson, Holotype, United States National Herbarium.



Liabum trianae H. Robinson, Holotype, United States National Herbarium.



Liabum vargasii H. Robinson, Holotype, United States National Herbarium.

Enlargements of heads of Liabum. Top: Liabum barclayae and L. ferreyrii. Middle: L. kingii and L. macbridei. Bottom: L. trianae and L. vargasii.

A NEW SPECIES OF *VERNONIA*

FROM ECUADOR

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Smithsonian Institution, Washington, D.C. 20560.

The alternate-leaved condition is sufficiently characteristic of the tribe Vernonieae to be one of the most useful means for distinction from some other groups such as the Liabeae. Opposite leaves do occur in the Vernonieae, however, especially among some members of the genus *Vernonia* sect. *Critoniopsis*. Such plants may not always be immediately recognized as members of the tribe and the new species described below was encountered in a loan of material sent for a study of the Eupatorieae of Ecuador by R.M.King.

Cuatrecasas (1956) has provided a key to the Andean species of *Critoniopsis*, but because of the combination of opposite leaves and glabrous outer surfaces of the involucral bracts the new species does not fit into the key. Cuatrecasas does give two species, *V. crassilanata* Cuatr. and *V. trichotoma* Gleason, having opposite leaves with the character being unreliable in the former species. Also in the Andes is *V. chimboracensis* Hieron. with opposite leaves and *V. pichinchensis* Cuatr. with the leaves tending to be opposite or subopposite. Of the above species two are obviously not closely related to the new Ecuadorian specimen; *V. crassilanata* has a totally different habit with numerous small oblong-elliptical leaves and longer pubescence, and *V. pichinchensis* has much smoother leaves and only 4 flowers per head. For *V. chimboracensis* only the description and type photograph have been seen but the plants apparently have smoother upper leaf surfaces, more reflexed leaf margins, heads with 11-12 flowers, an involucre with ca. 20 bracts up to 8 mm long, corollas ca. 6 mm long with tubes 2 mm long, 40-50 inner pappus setae about 5 mm long, 20-30 outer setae scarcely 2 mm long, and immature achenes ca. 3 mm long. The smoother leaves and different sized of involucral bracts and flowers seem particularly notable. The remaining species, *V. trichotoma* of Colombia, differs from the new species by the more acute leaves, the larger heads, the more pubescent involucres, and the numerous hairs on the outer surface of the corolla lobes. The latter species does have the same upper leaf surface seen in the new species, however, and it would seem to be the closest relative.

The close relationship between the new species and V. trichotoma would suggest some stability of the opposite-leaved condition in both species, but it has seemed wise to compare the Ecuadorian plant with some alternate-leaves members of the section Critoniopsis. Most of the latter prove to differ in having heads with only 1-6 flowers. Still, there is one species with more flowers to which the new species might key in the Cuatrecasas treatment, V. huairacajana Hieron. Description and photographs of the latter indicate a more bullate upper leaf surface, a more pyramidal inflorescence, and longer inner involucral bracts among other character differences.

At least one other opposite-leaved species of Vernonia sect. Critoniopsis is found in South America, V. stellata (Spreng.) Blake of Brasil. The latter is notable for the longer unbranched stalked hairs on the stems, leaves, and involucral bracts.

Vernonia sparrei H. Robinson, sp. nov.

Plantae arborescentes? laxe ramosae. Caules subteretes leniter sexangulares dense fulvo-puberuli, pilis breviter T-formibus inflatis plerumque 100-150 μ longis et 30-40μ latis, internodis 8-20 mm longis. Folia opposita, petiolis 5-15 mm longis dense puberulis non alatis; laminae oblong-ellipticae 3-7 cm longae et 1.3-3.7 cm latae base late cuneatae margine integrae vel subtiliter sinuosae apice rotundatae et minute emarginatae vel apiculatae supra plerumque glabrescentes in nervis primariis persistentiter breviter puberulae, pilis 200-700μ longis, nervulis distincte intricate prominulis; subtus fulvo-tomentellae et glanduliferae, pilis T-formibus vel tricornutis, nervis pinnatis, nervis et nervulis valde elevato-reticulatis. Inflorescentiae terminales dense subcymosae vel corymbosae, pedicellis 2-7 mm longis valde sulcatis dense fulvo-puberulis vel tomentellis, pilis 2-3-ramosis 200-300μ longis. Capitula ca. 9 mm alta et 5 mm lata. Squamae involucri ca. 30 ca. 5-seriatae valde inaequales 0.5-5.5 mm longae plerumque 2 mm latae late ovatae vel oblongae apice perobtusae indistincte maculatae margine subscariosae interdum breviter incisae extus plerumque glabris superne sparse puberulae. Flores ca. 9 hermaphroditi. Corollae pallidae, tubis et faucis combinatis 3.5-4.0 mm longis plerumque 0.4-0.5 mm latis, tubis plerumque glabris, faucis indistinctis extus glanduliferis, lobis 2.0-2.3 mm longis et 0.6 mm latis lineari-oblongis extus persparse breviter setiferis apice pauce glanduliferis; thecae antherarum 2 mm longae inferne obtusae in parte

dentatae; appendices ovatae ca. 0.4 mm longae et 0.3 mm latae; styli in 0.1 mm basilaribus valde demarcati, cellulis distinctis subquadratis 10-20μ diam. Achaenia 1.5 mm longis 0.7-0.8 mm latis in sulcis et basis glandulifera superne pauce breviter spiculifera; carpopodia distincta ca. 0.2 mm alta et 0.4 mm lata, cellulis quadratis ca. 15-seriatis ca. 12μ diam, parietibus incrassatis; setae pappi longiores ca. 40 plerumque 5 mm longae leniter complanatae apice distincte incrassatae, cellulis lateralibus exterioribus et apicalibus breviter acutis; setae in serieibus exterioribus indistinctae plerumque 0.5-1.5 mm longae. Grana pollinis 35-40μ diam. leniter lophorata, cristis valde spiniferis.

TYPE: ECUADOR: Loja: Nudo de Cajanuma, ca. 6 km S Loja, shrub forest, ± 2400 m. 14/5 1967. B.Sparre 16056 (holotype S).

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Vernonia sparrei H. Robinson, Holotype, Stockholm. Photo by Victor E. Krantz, Staff Photographer, National Museum of Natural History.

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CALIFORNIA POLLINATION ECOLOGY AND VEGETATION TYPES

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California plant communities which are physiognomically similar but geographically disjunct exhibit remarkable similarities in their pollination dynamics. In contrast, dynamics differ markedly in adjacent communities which do not share a common vegetative structure (Moldenke 1971, 1975). Many parameters of community structure or dynamics (e.g., species diversity, patterns of specialist/generalist food web relations, percent selfing, ploidy levels, percent wind pollination) are not dependent upon the presence of particular species, but are characteristics apparently imposed by climate and/or vegetation, regardless of the flora.

Most attributes of pollination dynamics of California are those generally associated with temperate and semi-arid ecosystems: 1) low diversity of forest trees; 2) moderate diversity of shrub species in scrub communities; 3) high diversity of bee pollinators; 4) low abundance and species diversity of hummingbirds and social bees (except in certain special environments); and 5) generally short blooming periods for most angiosperms, although not as short as those reported in the tropics.

The data presented in this paper are largely based on eight years of research by myself and associates (Moldenke, 1971, 1975 and 1976). A transect was established across central California which incorporated 0.5 km^2 areas of northern coastal scrub, dune scrub, oak-madrone forest, oak woodland, hard chaparral, serpentine grassland, ponderosa pine forest, montane chaparral, mountain meadow, subalpine forest, subalpine marsh-meadow, subalpine talus fell-field and alpine tundra (Moldenke 1975). In southern California, several additional sites were established in coastal sage and dunes, burned and mature chaparral, oak-pine forest and Sonoran Desert scrub (Moldenke 1976, and unpublished data). In all, more than 800,000 pollinators on 2,200 plant species were recorded. In order to establish the veracity of the observed behavior and to permit generalization over a larger geographic extent, a catalogue of the distribution, abundance and host-preferences of all specimens in the major California bee collections has been compiled by Moldenke and Neff (1974).

Table 1.	Alpine Mono Co.	Subalpine: Tioga Pass			Mid-elevation: Mather			Sea Level: Stanford Univ.			
	Tundra	Meadow	Forest	Talus Scree	Grassland	Forest	Chaparral	Chaparral	Forest	Woodland	Grassland
Bees											
(species)	36	36	72	91	146	165	141	176	23	136	163
(individuals)	716	1060	1241	4176	38716	33122	26400	7769	640	2858	19602
Beetles											
(species)	2	10	16	27	37	36	63	101	13	33	47
(individuals)	26	74	4131	1634	51039	27063	119116	93591	2636	20166	57161
Butterflies											
(species)	19	19	15	60	24	26	13	25	2	20	35
(Individuals)	200	37	68	664	2767	1837	3710	669	35	229	3801
Muscoid Flies											
(species)	5	45	44	53	19	9	16	26	0	6	24
(individuals)	94	1416	1588	3485	525	86	321	886	0	202	3345
Syrphid Flies											
(species)	4	7	16	21	18	21	23	17	9	18	22
(individuals)	15	17	83	132	682	69	927	278	47	264	925
Bee Flies											
(species)	4	1	5	9	24	26	10	26	3	11	31
(individuals)	48	2	12	48	4842	4493	26438	2393	350	910	6699
Wasps											
(species)	6	0	4	21	30	23	22	36	1	15	26
(individuals)	7	0	11	141	1100	811	874	245	15	292	448
Hummingbird and Sphyngid Moth											
(species)	2	2	4	4	1	3	2	1	1	1	1
(individuals)	22	6	52	196	20	14	87	202	15	159	31
Total Species	77	158	202	337	326	327	316	484	63	260	386
Total Individuals	1182	5101	10263	13681	100827	68640	170375	115396	6368	30732	98452
Total Biomass	511843	268407	820249	1858722	3477601	3095022	6864100	2526500	293847	1694023	2922640

Table 1. (cont.)	Point Reyes Scrub & Dunes	Coastal Sage	San Diego County Burned Chaparral	Chaparral	Montane Forest	Desert
Bees						
(species)	50	80	151	171	135	87
(individuals)	29859	3158	6297	55789	11032	9905
Beetles						
(species)	7	7	16	41	17	24
(individuals)	266	133	4024	4923	3195	570
Butterflies						
(species)	3	3	13	15	13	4
(individuals)	29	68	2732	2750	78	14
Muscoid Flies						
(species)	9	10	11	19	8	5
(individuals)	223	55	417	140	196	755
Syrphid Flies						
(species)	17	4	1	6	3	3
(individuals)	297	15	80	79	180	240
Bee Flies						
(species)	4	7	22	24	16	22
(individuals)	695	261	4200	4989	1470	640
Wasps						
(species)	3	7	38	31	13	36
(individuals)	65	69	335	804	63	453
Hummingbird and Sphyngid Moth						
(species)	1	1	2	2	2	1
(individuals)	45	73	133	187	73	44
Total Species	103	119	254	309	207	182
Total Individuals	31968	3782	18218	69623	16287	12621
Total Biomass	2531785	664993	2236405	3012421	1350936	1530381

TABLE 1. Abundance of Pollinator Groups in California Vegetation Types. Major pollinators within vegetation types as determined at sites 0.5 km^2 in extent. Figures refer to number of insect species and individuals. Biomass estimate based on measurement of length, width and height of each species multiplied by total individuals of that particular species in the census. Flower visiting groups rare in all communities are excluded from the table. From Moldenke (1971 and 1975).

These results must remain somewhat tentative, since conclusions drawn about the flower-visiting preferences of each of the 1,000+ species of bees inhabiting California needs to be corroborated with, at the very least, an analysis of the pollen loads carried by specimens in museum collections. Collection records associated with museum specimens are of course indicative of instances of floral visitation, but bees which exhibit the genetically determined feeding preferences do so for pollen and not for nectar. Hence, since fidelity to source is an important aspect of pollination efficiency, species-specificity of pollen gathering by bees is an extremely significant facet in the dependable pollination of plant genera over large geographic ranges, nearly independent of localized patterns of distribution and competition for pollinators. The conclusions we have reached (Moldenke and Neff 1974) err on the side of the conservative, in general. Particular emphasis has been placed on patterns typical of genera or species groups, when incomplete evidence suggests a deviation from the typical pattern, no conclusions about host-specificity are reached. Hence, instances of specialization by localized populations on abnormal host plants or the specialization by a very rare species on a plant unrelated to the host of a well-known common species, are not recognizable on the basis of our present data base. The general trends cited below, though, are very clear and represent the major features of California pollination dynamics even though we are far from working out all the details of such a comprehensive subject.

In terms of total numbers of species, pollinator diversity in California is highest in hard and montane chaparral, where it is generally 25%-33% higher than in grasslands (Table 1). Diversity is cut by 50% in northern coastal scrub, coastal sage and dune scrub (ca. 105 spp. 0.5 km^{-2}) from that observed in the adjacent chaparral. Pollinator diversity plummets in alpine tundra and mixed-evergreen forest to a low of about 70 spp. 0.5 km^{-2}. On a regional basis, pollinator abundance is highest at Mather (230,000 km^{-2}), drops slightly at Stanford (160,000 km^{-2}, discounting evergreen forest), then falls precipitously to 46,000 km^{-2} throughout San Diego County sites (Table 1). Even lower pollinator densities are noticeable at Point Reyes (21,000 km^{-2}), at subalpine Tioga Pass (18,000 km^{-2}), in mixed evergreen forest (12,000 km^{-2}), and in the alpine tundra at Dore Crest (3,500 km^{-2}). We shall return to this table in the next section.

With few exceptions, the majority of the outcrossed plant taxa in California are visited by many different types of pollinating agents: 71% are visited by at least two distinct pollinator types, 49% by three or more (Table 2). Only the most highly specialized taxa are visited by one type of vector agent exclusively; but even then, the different species within these genera are often serviced by the same vector species. It should be noted that these generalizations about the pollination spectra of California undoubtedly underestimate the degree of broad spectrum syndromes; with the paucity of solid field data and scarcity of published reports, many plant genera cited as primarily pollinated by only one vector type are artifacts of our own studies which were localized in their very nature.

The most important pollinators throughout California are probably hummingbirds, certain bees (e.g., bumblebees, Anthophora and oftentimes semisocial halictine bees), large beeflies (Bombyliidae) and butterflies. These groups vector pollen for considerable distances and/or visit many plant taxa which are ignored by the majority of other pollinator groups. Although specialist bees which visit only a single plant species are seldom of primary importance in the pollination of California plants, under certain circumstances their presence is to the plants' advantage, for these bees will search out their flowers and pollinate them preferentially, even if the plants are in low abundance. The honeybee (Apis mellifera) was introduced into California in the late 18th century and is so widely domesticated and so successful in feral circumstances that it is an integral part of the present pollination ecology of all regions except the alpine tundra and the densest forests. The major effects of Apis have been the competitive local extinction (undocumented but presumably extensive) of many pollinator taxa (especially solitary bees) and the heavy outcrossing of many native plant taxa presumably highly inbred prior to the establishment of dense honeybee populations.

The most frequent and diverse group of insect flower visitors in California are the 1,200 native bee species. Approximately 800 of them are implicated as feeding specialists, programmed to visit only a closely related group of plant species (Moldenke and Neff 1974). Indeed, these specialist solitary bees are often local species-specific pollination specialists, generally active for very short periods (2-4 weeks average), and usually discontinuously distributed but locally abundant. Similar high bee diversity characterized Mediterranean

and desert ecosystems throughout the world (Linsley 1958; Moldenke 1976). Since nearly all the plant species serviced by specialist pollinators are visited as frequently (if not more so) by generalist species (84%; Table 2), and since generalist species are often capable of moving considerably longer distances between members of the same species than are the often small and highly localized specialists, competition for vectors usually involves competition for large-bodied, fast-flying, heterothermic generalists. The most successful competitors for these effective vectors often derive a secondary benefit as well; these "polylectic" generalist bee species may utilize a very diverse assemblage of plant species across the broad expanse of their distribution, at a given site they often facultatively specialize upon whatever local resource provides the best reward, facilitating the effectiveness of the pollination syndrome markedly.

At least ninety-one genera of California plants have coevolved with specialist solitary bees that are restricted to species of that particular genus or a very closely related plant genus. Additionally, 68 plant genera are known to be strongly associated with solitary bees that are family-specific, particularly to the Compositae and the Papilionoideae, in their host preferences. With very few exceptions, the larger the number of specialist vectors that a plant genus is serviced by the larger is the number of generalist pollen vectors as

TABLE 2. Pollination Syndromes of the California Flora. Vector categories represent the most efficient modes of pollination for a particular plant genus rather than simply the total flower visitors. Every effort was made to limit the total categories applicable for each genus to exclude an emphasis on infrequent flower visitors. Conclusions are based on my own research at defined sites throughout the state, consultation with colleagues and the results of our bee catalogue (see Appendix).

A. Only categories with listings more than 5 included in table;
B. Indicates pollination by indicated mode and at least two others;
C. Indicates pollination by indicated mode and at least one other;
D. Obligate selfing is a subset of habitual selfing;
E. Difficult to delineate between modes without further investigation (57 taxa cited jointly).

Table 2.

POLLINATION MODE																
Water Pollination	Wind Pollination	Obligate Selfer (D)	Habitual Selfer (E)	Generalist Bees (E)	Specialist Bees	Hummingbird	Sphinx Moth	Moths (nocturnal)	Butterflies	Wasps	Beetles	Muscoid Flies	Beeflies	Syrphids	Primitive Flies	# California Genera Possessing Stated Mode of Pollination (A)
X																5
	X															136
		X														76
			X	(x)												246
			(x)	X												66
				X	X											27
					X											9
						X										10
				X		X										22
							X									3
								X								4
									X							2
										X						0
				X						X						5
											X					1
				X							X					9
												X				5
				X								X				4
													X			5
				X									X			15
				X	X								X			7
														X		0
				X										X	X	18
															X	6
				X		(← 2 x →)										49 (B)
				X	X	(← 1 x →)										20 (C)
				X	X	(← 2 x →)										70 (F)
	X			(← 2 x →)												5 (E)
						(← 2-5 x →)										27

well. Exceptional genera pollinated almost exclusively by specialist bees are Calystegia, Camissonia, Coldenia, Collinsia, Cucurbita, Euphorbia, Physalis and Zigadenus.

The dominant form of pollination in all but the desert and chaparral communities is, of course, anemophily, as it is throughout the temperate and subarctic zones of the world. There are very few groups of wind-pollinated plants endemic to California; most of our taxa are very widespread and their pollination adaptations do not seem to be peculiar to California.

Eighteen percent of the angiosperm genera with non-anemophilous flowers are unsuccessful at, or at least inconsistent in, attracting abundant pollinators. These genera seem to be consistently selfed, though under certain unusual situations they may be efficiently outcrossed. Many of these genera are endemic to California and presumably evolved under conditions of pollinator abundance similar to those observed presently (e.g., Achyrachaena, Allophyllum, Amblyopappus[a], Apiastrum, Athysanus, Downingia, Eatonella, Emmenanthe, Gayophytum[a], Nemacladus, Pectocarya[a], Plagiobothrys[a], Psilocarphus[a]). Endemic origin of some obligately selfing taxa is pronounced in more widely spread plant genera usually characterized by genetic self-incompatibility and heavy visitation rates (e.g., Astragalus, Eriogonum, Lasthenia, Layia, Lotus, Lupinus, Mimulus, Orthocarpus).

POLLINATION CHARACTERISTICS OF VEGETATION TYPES

Forests

The low diversity of the varied forest types of California permits successful wind pollination. As Bateman (1946) and Colwell (1951) have shown, wind pollination is normally extremely inefficient. The success of wind pollination decreases with the cube of the distance between plants, and for trees more than 100 feet apart, the chance of successful pollen transfer becomes vanishingly small, even considering the astronomically large number of pollen grains produced. Successful wind pollination can be increased by decreasing the surface area of nonstigmatic surfaces, through such evolutionary adaptations as needlelike or filiform leaves (conifers, Artemisia californica) and leaflessness (some Quercus, Platanus, Fraxinus) at the time of pollination. Three of the four nonwind-pollinated forest tree

[a] California evolutionary origin with subsequent "sweepstakes colonization" of Chile (Raven 1963).

species in California (Arbutus, Umbellularia, Acer) occur in the diverse mixed evergreen forest, in which wind pollination would be a severe disadvantage.

Within the understory, cross-pollination is a function of sun-dappling (Beattie 1971). Nearly all forest floor pollinators are most active in direct sunlight; neighboring shaded plants as little as 15 cm away are seldom if ever visited. Forest floor pollinators for whom this behavior is characteristic, particularly bees and butterflies, still must be able to fly between the sun-dapples in order to exploit sufficient resources for sustained activity. The most abundant and significant pollinators of the forest floor are bumblebees and Bombylius major, a beefly. Their activity is maximized by a facultative homeothermy (Heinrich 1974), which allows sustained flight within shade in order to locate a maximum number of thermally advantageous sunny spots. These insects are characterized by very low surface/volume ratios; dense, dark, absorptive insulatory pubescence; and large body size necessary for the maximal conservation of metabolically produced heat. The bees, Andrena and Nomada, and the nematoceran and muscoid flies --also responsible for much California forest pollination --are poikilothermic.

Compatibility studies have rarely been undertaken on wind-pollinated tree species. Most species are monoecious (conifers, Quercus, Platanus), an adaptation clearly designed to promote outcrossing. It is not known whether selfing is possible or whether, if possible, selfed seed competes favorably with outcrossed seed of the same species. Genetic fine-tuning to the environment is a well-documented result of outcrossing (hybridization) in the oaks of the Santa Lucia Mountains (Griffin 1973).

Forest understory species are mainly perennial geophytes or sprawling woody subshrubs or vines; annuals are rare except in the most open savanna forest types. In all low-elevation forests, nearly the entire understory blooms exclusively in early spring. Most of these plants are derivatives of the widespread Arcto-Tertiary Geoflora and have evolved anthesis periods synchronous with the maximum probability of light-dappling, prior to leafing-out and the replacement of winter-killed branches. Most of these forest floor perennials are genetically self-incompatible and obligately require outcrossing vectors. There are no confirmed specialist

vectors[b] in these environments, and the pattern of synchronized blooming places plants in strong competition for vectors. In order to maximize the visibility of flowers on the forest floor, natural selection has acted convergently to produce a flora with an overwhelming preponderance of white flowers, a rather uncommon flower color in most other native plant communities. Recognition by distinctive scents accounts for the specialized pollination syndromes of the brownish-flowered Asarum, Aristolochia and Scoliopus.

In the north coastal forest, pollinators of any sort are extremely infrequent. All the major groups appear to be entirely absent. In the narrow riparian coastal forests, pollinators may stray in from surrounding communities (hummingbirds for Lilium, Aquilegia; bumblebees for Oxalis, Arbutus; Bombylius major for Trientalis, Collomia), but in the midst of large expanses of conifer forest they are virtually absent. The major pollinators in these situations probably are primitive nematoceran gnats and midges and occasional bumblebees. Bumblebees inhabiting these regions are so infrequent that they have not been well-studied; there may be special forest-adapted species (perhaps Bombus caliginosus, B. sitkensis) that are able to locate flowers in low-light conditions and characteristically have very small colony populations due to the brevity of the blooming season. The only frequent flower visitors in these situations are the primitive flies. Their extremely small size and poor powers of flight apparently render them extremely inefficient pollen vectors, but under conditions in which they are the only potential vectors, they presumably exert a major vector influence in the community. Asarum (Vogel 1973) and Aristolochia are pollinated by fungus gnats attracted to the flower by scents resembling their normal mushroom food sources.

In the mixed evergreen forest of the Coast Ranges, there are many more herbs on the forest floor and considerably more sundapples. Pollinators are infrequent, but bumblebees (Bombus spp.), beeflies (Bombylius major), and solitary bees (Andrena spp. and its inquiline cuckoo-bee parasite, Nomada spp.) are the most significant

---

[b] Several species of as yet unstudied solitary bees may be found to be at least facultative specialists in localized regions (e.g., Andrena nigrihirta on Dentaria californica and Dialictus ornduffi on Jepsonia.

vectors. All vectors are active primarily in the earlier spring; none are known to be specialists. The most massive floral resource is Arbutus menziesii. Within the forest it is pollinated primarily by Bombus edwardsii, although long-distance pollination by nectar-feeding chickadees and hummingbirds is significant. Unlike most other bumblebee species, B. edwardsii along the central coast may remain active all winter long, presumably existing on stored food harvested during the previous season, and is apparently at maximum colony size during the Arbutus bloom, at which time it produces enormous quantities of sexuals and disbands to start new colonies (Moldenke, unpublished data).

In the montane and subalpine forest belts, forest floor pollination is primarily mediated by bumblebees and the solitary Osmia bees. Osmia is primarily associated with legumes (Vicia, Lathyrus, Lupinus) and composites (Wyethia, Helianthella, Agoseris) and is most abundant in areas of disturbance or regions bordering mountain meadows. Osmia carries the collected pollen on the undersurface of its abdomen and hence is an extremely efficient pollinator of the upward projecting stigmas of these two plant families. Numerous species of bumblebees reside in montane forests and visit nearly all flower types; they are most abundantly associated with the Leguminosae, Rosaceae and Compositae. With increasing altitude, bumblebees become much less abundant as much of the forest understory drops out; nevertheless, they assume nearly the entire pollination function as most other vector types drop out completely. Andrena, Nomada and Bombylius are important, especially at altitudes less than 2,000 meters.

In more open montane forest types (e.g., ponderosa pine), a great deal of direct sunlight reaches the forest floor and a much wider diversity of flower types and colors exists than in the previously discussed forest types; annual plants are often abundant. Pollinators generally are not specialists; if so, they are usually specialists to the family level only (roses, legumes, composites). In the most open forest types, such as oak-woodland, understory plants aften assume at least ninety percent cover and pollinators of all groups are abundant. Wind pollination is frequent in the understory, with few self-incompatible outcrossing species (e.g., Bromus laevipes), but numerous self-compatible facultative selfers (e.g., Festuca, Stipa, Elymus, most annual Bromus). Butterfly (composites, Monardella) and hummingbird (Grossularia, Ribes, Delphinium, Monardella, Penstemon, Erysimum) pollination

CENTRAL CALIFORNIA

Table 3.	Dore Alpine Tundra	Tioga Pass Subalpine Meadow	Forest	Talus Scree	Mather Mid-elevation Grass-land	Chap-arral	For-est	Stanford University Sea Level Chap-arral	For-est	Oak wdld	Grass-land
Solitary Bee	20 27%	13 9%	26 19%	38 20%	40 40%	37 62%	56 30%	41 42%	18 17%	60 45%	59 41%
(Specialist Bee)	11 15%	9 6%	14 10%	27 15%	28 28%	22 37%	23 13%	18 19%	2 2%	21 16%	29 20%
Halictine Bee	/	4 2%	13 9%	30 17%	7 7%	8 13%	10 6%	13 14%	5 5%	11 9%	20 14%
Bumblebee	18 24%	22 15%	26 19%	40 22%	12 12%	28 47%	37 21%	8 8%	19 18%	19 15%	16 10%
Beefly	/	/	2 2%	9 5%	16 16%	14 23%	32 17%	12 12%	9 9%	18 15%	29 20%
Beetle	/	/	6 5%	10 6%	13 13%	9 15%	9 5%	19 20%	5 5%	14 10%	24 16%
Wasp	1 1%	/	/	1 0%	2 2%	5 7%	5 3%	5 5%	2 2%	4 3%	2 1%
Butterfly	6 8%	2 2%	4 4%	15 8%	13 13%	12 20%	7 4%	7 7%	1 1%	3 3%	13 7%
Moth	2 2%	1 1%	/	2 1%	2 2%	/	/	2 2%	/	3 3%	1 1%
Muscoid Fly	4 5%	24 16%	20 16%	15 8%	3 3%	1 1%	3 2%	6 6%	/	2 2%	4 3%
Syrphid Fly	1 1%	3 2%	/	4 2%	4 4%	2 3%	2 1%	7 7%	6 6%	11 9%	7 4%
Hummingbird and Sphyngid	3 4%	3 2%	6 5%	11 6%	1 1%	7 12%	5 3%	7 7%	3 3%	7 6%	4 3%
Wind	19 25%	50 35%	37 29%	38 20%	31 31%	7 12%	22 12%	11 12%	20 19%	25 18%	23 16%
Habitual Selfer	29 39%	28 19%	30 22%	65 35%	42 42%	4 7%	47 25%	14 15%	19 18%	29 22%	57 41%
(Obligate Selfer)	2 3%	7 5%	2 2%	15 8%	4 4%	1 1%	6 4%	4 4%	5 5%	7 6%	27 18%
Apomictic	6 8%	11 8%	7 6%	12 7%	/	/	2 1%	1 1%	1 1%	/	1 1%

Table 3. (cont.)	CENTRAL CALIFORNIA		SOUTHERN CALIFORNIA				
	Pt. Reyes Sea Level	Farallon Is	Torrey P.	Descanso		Laguna	Ocotillo
	Scrub Dunes		Coast Scrub	Chap. Burn	Chap-arral	Mont. For.	Des-ert
Solitary Bee	23 12%	/	37 27%	35 24%	32 41%	33 41%	34 29%
(Specialist Bee)	9 5%	/	24 18%	18 12%	20 29%	16 20%	24 21%
Halictine Bee	18 9%	/	10 7%	8 5%	5 7%	1 1%	2 2%
Bumblebee	81 40%	/	/	/	/	/	/
Beefly	5 3%	/	3 2%	11 7%	4 6%	7 9%	2 2%
Beetle	4 2%	/	4 3%	3 2%	/	3 4%	3 3%
Wasp	1 1%	/	1 1%	8 5%	2 3%	2 3%	5 4%
Butterfly	2 1%	1 3%	3 2%	4 3%	1 1%	1 1%	2 2%
Moth	/	/	/	/	/	/	/
Muscoid Fly	3 2%	3 9%	1 1%	1 1%	2 3%	1 1%	3 3%
Syrphid Fly	6 3%	6 18%	3 2%	3 2%	/	/	4 4%
Hummingbird and Sphyngid	7 4%	/	4 3%	8 5%	10 14%	6 8%	3 3%
Wind	32 16%	3 9%	21 15%	16 11%	7 10%	16 20%	13 11%
Habitual Selfer	60 30%	31 93%	45 33%	35 24%	6 9%	10 13%	44 38%
(Obligate Selfer)	22 11%	9 27%	12 9%	9 6%	1 1%	3 4%	7 6%
Apomictic	4 2%	/	/	/	/	/	/

TABLE 3. Pollination Syndromes of California Vegetation Types. Major pollinators within vegetation types as determined at sites $0.5\ km^2$ in extent. Figures refer to number of plant species and percent of the resident flora. Pollinators utilized are those actually observed, rather than speculation based on flower morphology. Percentages sum to more than 100% since some species utilized more than one mode as their usual pattern of reproduction. Specialist bees represent a subset of solitary bee statistics; obligate selfers represent a subset of habitual selfing. From Moldenke (1971, 1975).

assumes an important role. Species diversity of both angiosperms and pollinators (particularly bees) approaches the high levels found in the Mediterranean scrub and grassland (Table 1).

Chaparral: hard and soft

Wind pollination rarely occurs among the shrubs and subshrubs of chaparral (Artemisia, Garrya are exceptions); only along the fog-shrouded coast, where pollinators are very scarce, does wind pollination occur for a dominant species (Table 3). Though wind pollination would be facilitated by the low diversity of dominant shrubs, insect and bird pollination is the rule, just as it is in the physiognomically analogous matorral of Chile (Moldenke and Neff, in press). Abundance of insects associated with flowers and species diversity of pollinators are extremely high even in small regions (484 species of flower visitors in chaparral at the Stanford University site), eight times the number of species in the adjacent forest and eighteen times the number of individual insect vectors observed. Such extremely high diversity and abundance of pollinators must result in a very strong over-all competition by pollinators for plant species. Nearly all chaparral dominants are associated with specialist pollinator taxa. Nevertheless, competition among plant species for some of the more mobile and extremely common generalist pollinators has resulted in the evolution of distinct, mutually exclusive anthesis times (Mooney, 1972; Moldenke, unpublished data). This exclusivity of blooming periods is facilitated by the extremely large root systems of Mediterranean scrub species (Mooney, 1972), enabling scrub species to tap stored water supplies well into the summer drought. Species that have been forced to bloom in the earliest part of the year, when it is frequently too wet and cold for pollinator activity, are extremely poorly pollinated and are self-incompatible (e.g., Osmaronia, Dirca); they are not associated with specialist pollinators.

Almost all chapparal shrubs are genetically incompatible, or, if compatible (e.g., Diplacus) or undetermined (e.g., Eriodictyon), they are heavily outcrossed by extremely abundant pollinators and possess mechanical adaptations which decrease the potential for selfing. Most chaparral shrub species are very heavily visited by pollinators; all groups are present in abundance. Aesculus is of particular interest because it is pollinated by butterflies (Euphydryas, Strymon) and sphyngid moths. All species of Aesculus secrete a nectar that is poisonous to bees, interfering with the normal development of the larva (Benseler, 1968).

The most significant features of the chaparral permitting the extraordinary abundance of bee species are the absence of ground cover, providing ample nesting sites for ground-nesting species, and the frequency of fires, which continually renews supplies of dead branches for twig-nesting species. In mature chaparral, the very few annuals which occur under the canopy are self-compatible and extremely heavily outcrossed by nectaring bees or parasites patrolling suspected bee nest sites. Just after a burn, annuals and geophytes represent the entire floral resource. Most species are capable of selfing and usually are forced to do so in the absence of large numbers of recolonizing pollinators, though some of the most abundant species are genetically incompatible (e.g., Brodiaea, Corethrogyne, and certain species of Orthocarpus, Salvia, and Amsinckia). However, within two to three years after a fire, large pollinator diversities build up (Moldenke and Neff, 1976) and some species of fire-sprouted forbs are then heavily visited by specialist and generalist vectors in great abundance (e.g., Phacelia, Lotus, Lupinus, Penstemon). Emmenanthe penduliflora, an obligate fire-sprouted annual, is usually limited in appearance to the very first year after a fire; two specialist bee pollinators (Protodufourea wasbaueri and Conanthalictus seminiger) have coevolved with this plant. Since the bees are not known to remain in aestivation until activation by fire, it is unclear how they are capable of relocating a resource during subsequent years or how this association might have originally evolved.

Unlike most other California vegetation types, the chaparral exhibits some nocturnal moth pollination (Aesculus, Adenostoma, Heteromeles, Prunus)associated with masses of small white flowers. There are often large populations of bumblebees, which are particularly significant as pollinators in the cool, early spring. At Mather, I have even observed queen bumblebees foraging on Arctostaphylos during a clear night at midnight with 15 cm of snow still on the ground. There is often a high diversity and abundance of halictine bees (oftentimes semisocial colonial units) in chaparral, which are efficient pollinators when facultatively specialized due to the nonoverlapping anthesis seasons. Sphecid wasps are frequent flower visitors in the Sierra Nevada.

Grasslands

The floral productivity of California grasslands varies greatly from year to year as a function of rainfall. Harvester ant seed predation also continuously alters the distribution and relative abundance of flower types. Under all conditions, anemophily is the dominant form of pollination. Though only 16%-31% of the species are wind-pollinated in any local region, most of the dominant species, comprising 20%-40% of the floral biomass, are wind-pollinated. The grasslands were originally dominated by *Stipa*, which is apparently heavily outcrossed, although genetically capable of selfing. Nearly all the common grasses today, including the introduced weedy species, are generally outcrossing facultative selfers, exceptions being *Koeleria cristata*, *Poa scabrella*, and *Lolium perenne*, which are genetically incompatible. The diminutive species often found in serpentine areas (*Festuca* spp., *Plantago erecta*) are often cleistogamous, as are many of the small individuals of *Bromus mollis*. Certain dominant grassland forbs are genetically incompatible (e.g., *Lasthenia chrysostoma*, *Layia platyglossa*, *Eschscholzia californica*, *Orthocarpus densiflora*, *Brodiaea* spp.), But the overwhelming majority of species are compatible (79%; Moldenke 1971).

Habitual selfers are most abundant in grassland communities (41%-42% of the serpentine grassland flora at Stanford and the mountain meadow at Camp Mather; Table 3). Many of these habitual selfers are in reality obligate cleistogamous selfers (*Achyrachaena mollis*, *Astragalus gambellianus*, *Lupinus concinnus*, *Lepidium nitidum*, *Amsinckia menziesii*, *Orthocarpus pusillus*). Eighteen percent of the species are obligate selfers, a level in excess of that observed in other vegetation types, and approached only by the annual constituent of the dune scrub and coastal sage (9%-17%). Obligate selfers in grasslands usually bloom before the period of activity of the pollinators. At Stanford, pollinator diversity and biomass starts to rise noticeably during the first week in April; by this time, 68% of the 27 obligate selfers have nearly finished blooming.

The usual grassland pollinators are solitary and semisocial bees, beeflies and butterflies. Hummingbirds are scarce (present on *Delphinium* spp. and *Salvia carduacea*). Nocturnal pollination is very infrequent. There are generally large numbers of specialist-feeding pollinators. Many sympatric, congeneric specialist bee species occur on the dominant species, particularly *Andrena* in the spring and *Megachile* and *Melissodes* in

the summer; the mechanisms by which they escape extinction through competition are unknown. Whether the high diversity of pollinators confers any type of pollination benefit to the plant (such as predictability under all climates) is also unknown. Most of the pollinator groups associated with California grassland communities are derived from basic Nearctic pollinator stock, except for some of the later summer groups, which have evolved from the fauna associated with Tropical Middle American and Madro-Tertiary Geofloras (Moldenke 1976). Diversity of pollinators in native grasslands is extremely high. Many species are extremely abundant but often highly localized. Diversity often increases in oak savanna habitats as the shade extends the length of the blooming seasons and branches permit the existence of twig-nesting solitary bees.

Hot Deserts

Annual variability of floral production is extreme in desert ecosystems. Paradoxically, years characterized by abundant annual plants are usually characterized by extremely few pollinators; years of low precipitation and few flowers are apparently characterized by high diversity and abundance of pollinators. Entomologists have long wondered whether these observations were the artificial result of an alternating concentration and dilution effect produced by the distribution of resources, or if the observations reflected the real abundance of pollinators. My own studies and unpublished ones of Neff imply that the real abundance of pollinators does indeed fluctuate greatly from year to year. Years of cool, wet winters are most propitious for C_3 annual plants; however, cool weather is thermally most difficult for the activity of cold-blooded pollinators.

High winds characteristic of spring on the Colorado and Mojave Deserts are very detrimental to pollinator activity. Nearly all the dominant plants are genetically incompatible and outcrossed during years of high pollinator abundance. Nearly all the annual plants (exceptions include Camissonia, Oenothera) are genetically compatible and the great majority of populations self in all but the years of pollinator abundance. Floral size diminishes and genetic compatibility evolves as widespread angiosperm genera enter desert regions (e.g., Eschscholzia californica/E. minutiflora).

Desert regions are characterized by high bee diversity over a wide geographic extent, but on a small scale fewer species are present (87 in 0.5 km^2) than in

the chaparral (161 species), grasslands (153 species), or open montane forest (145 species; Table 1). More than 60% of the desert bee species are probably specialist feeders; they are associated with both perennial and annual floristic elements. In addition to solitary bees, beeflies and wasps play an important role in desert pollination systems. Hummingbirds are rare in deserts and are usually confined to mountain canyons where trees and shrubs may tap significant water flow. There, the syndrome of the large, nectar-laden flower coevolved with hummingbirds, is evident in such taxa as Fouquieria, Agave and Chilopsis.

In regions of bimodal rainfall, the summer and winter annuals are confined to only one season by germination and metabolic requirements. Similarly, most pollinators are limited to one or the other blooming season; spring season bees are generally derived from the Nearctic fauna while summer season bees are often Neotropical in derivation (Linsley 1958). There are no common large supergeneralized pollinators active in both seasons in the deserts of California. Even bees that are active in both rainy seasons (some Colletes and Perdita obliqua, a Prosopis specialist) produce two distinct generations during the year (Simpson et al. 1976).

Wind pollination is confined to several shrubs (e.g., Simmondsia, Franseria), infrequent subshrubby perennials (e.g., Stillingia, Tetracoccus), and grasses that bloom in response to summer rains. The shrubs have evolved either monoecy or dioecy to facilitate outcrossing; the grasses are often cleistogamous. Many of the Amaranthaceae and Chenopodiaceae in the shadscale scrub and alkalai sink communities are wind-pollinated but apparently habitually self when present in low density.

Two special features of desert pollination in California are crepuscular pollination and the substitution of oils for flower nectar. Several desert plants open their flowers in the late afternoon or the very early morning (e.g., Onagraceae, Cucurbitaceae, Nicotiana, Hesperocallis). Before the flowers wilt during the heat of the desert day, they are pollinated by large, heavily insulated, facultatively thermoregulatory insects such as sphinx moths and bees of the genera Peponapis, Xenoglossa, Xylocopa, Caupolicana and Andrena (Onagandrena). Crepuscular pollination in the other regions of California is limited to closely related species descended from these desert plant taxa, exceptions being Aesculus and Chlorogalum. The Krameriaceae and Malpighiaceae are pollinated exclusively by female Centris (Paracentris)

bees, which collect the oil produced by these plants as provision for their young (Simpson, Neff and Siegler 1977).

Alpine and subalpine vegetation types

Alpine regions of California are characterized by several distinct types of pollination systems (Moldenke 1975). In all of them, the relative percentage of generalist pollinators, by individual count or biomass, is extremely high, while total diversity of all pollinator groups is very low, especially beeflies and solitary bees. Anthomyiid flies, butterflies and bumblebees are the groups effecting most pollination.

The strongest emphasis on anemophily in California occurs in subalpine marsh-meadows, where 41% of the species are wind-pollinated. High diversity of sedges, rushes, and grasses militates against efficient wind pollination; however, most species are genetically compatible (all _Juncus_, _Luzula_, monoecious _Carex_ and most alpine grasses) and capable of apomictic propagule or vegetative propagation. Except for the locally abundant _Heleocharis pauciflora_, which occurs on shifting gravel banks of mountain meanders, all marsh-meadow residents are rather long-lived perennials. Reproduction by seeds is apparently extremely infrequent.

Pollinators are virtually absent in marsh-meadows. Nearly all insect pollination occurs through the agency of extremely inefficient (very poor flower constancy) anthomyiid flies of the genera _Hylemya_, _Pogonomyia_ and _Lasiops_. Occasional bumblebees and butterflies stray into the marshes and, as individuals, probably accomplish a level of outcrossing equivalent to several hundred flies. Widespread composite genera abundantly visited by diverse insect pollinators are represented in the marshes by predominantly selfed species (_Senecio subnudus_, _S. pauciflorus_ and _Erigeron lonchophyllus_). Normally outcrossed taxa (i.e., _Castilleja culbertsonii_, _Pedicularis groenlandica_) are much more frequently visited by bumblebees when growing only a few feet away from talus communities than when they occur centrally in marshes.

Talus scrub communities are characterized by a low diversity and abundance of pollinators, when compared to lower elevations; nevertheless, they support most of the species (86%) and nearly a majority of the pollinator individuals (49%) found in high alpine situations (Moldenke 1971, 1975). By species count,

the largest number of bees are specialist flower pollinators, but all of them are so rare as to comprise collectively only 28% of the bee fauna by biomass. Their extremely low population sizes and patchy distributions indicate that they apparently suffer frequent local population extinction and must recolonize. Most specialist taxa in the high alpine community types of the Sierra Nevada are apparently derived from the Great Basin (e.g., Anthocopa spp., specialists on Penstemon) and are characterized by wide elevational distributions on the east face of the Sierra Nevada. There are no moderately specialized bee species (oligophags); such species are abundant at low elevations, where they account for about 60% of the bee fauna. At middle elevations, generalists, extreme specialists and oligophags are equally represented (Moldenke 1975). At extreme elevations, however, climatic fluctuations are so severe and unpredictable that the jack-of-all-trades generalist is the most efficient competitor in light of fluctuating plant abundances.

Though floral biomass is not pronouncedly reduced over levels censused at lower elevations, pollinator abundance is much lower in subalpine vegetation types (115,000 individuals in chaparral scrub at Stanford; 13,000 individuals in talus scrub at Tioga Pass; Moldenke 1971, 1975). Very severe competition among flowering plants for the available pollinators results in many species remaining unvisited. Self-compatibility among perennial plants reaches its highest levels ($\bar{X}$ = 80%) in high-elevation California. Many plants are forced to self habitually (45%) and apomictic reproduction is frequent (Moldenke 1975). Some species in normally entomophilous genera and many apparently anemophilous plants are entirely cleistogamous or apomictic (e.g., Poa rupicola, Melica bulbosa, Erigeron compositus, Calamagrostis purpurascens, Arnica spp., Antennaria spp.). The very strong omnipresent winds militate against wind pollination and produce physiologically stressful conditions for flying insects. Pollinator taxa at altitudes of more than 4,000 m are usually species distributed in the far north of Canada as well.

The uniqueness of the breeding systems of the alpine flora is apparent in an examination of ploidy levels. Nearly 78% of the flora (Moldenke 1973, 1975) is polyploid. Furthermore, many of the taxa are greater than hexaploid. Though there are many explanations proposed for the evolution of polyploidy, the correlations Stebbins (1971) draws between polyploidy and the cyclic glaciation of the Sierra Nevada seems the most ecologically relevant.

Floral diversity measured in terms of $\underline{H}^{c}$ is noticeably higher in alpine communities than at lower elevations (average of all communities at Stanford, 2.62; Mather, 2.82; Tioga Pass, 3.19; and Dore Crest, 3.26). Since disproportionate relative abundances decrease values of $\underline{H}$ diversity, and since such disproportionate census counts are usually correlated with annual plants, this increasing floral diversity value at higher altitudes can be shown to be directly correlated to decreasing abundance of annual plants at higher altitudes. Annual plant species comprise 21% of the flora at sea level, 15% at 1,300 m, 6% at 3,000 m and were not observed at altitudes of 4,000 m.

Coastal vegetation types

Portions of the northern coastal scrub, coastal sage, coastal prairie, salt marsh and dune communities on the windward slope of the Coast Ranges or along bluffs adjacent to the ocean, have an exceedingly depauperate pollinator fauna and for convenience are best considered together here.

Coastal pollination conditions are similar to those in the high alpine except that the blooming season is not shortened. Moderating ocean breezes and generally omnipresent wind and fog hamper poikilotherm pollinator activity. On coastal bluffs and stabilized dunes, pollination is generally limited to thermoregulatory bumblebees, _Anthophora_ bees, and hummingbirds. From Point Lobos northward, the majority of the pollinators are disjunctly distributed in the High Sierra Nevada as well and thence continuously northward to Alaska and the Northwest Territories (Stephen 1955). Inland of immediate coastal exposure, the pollinator fauna of northern coastal scrub and coastal sage shifts to a depauperate chaparral fauna of very low density.

Wind pollination predominates in all salt and estuarine marshes; chasmogamous marsh forbs are pollinated by muscoid flies and bembicine sand wasps (E. Schlinger, pers. comm.) but nearly all are capable of habitual selfing. The muscoid flies and the occasional small-bodied solitary bees which live along the coast are restricted in the time of day and the number of days in which they can be active, by the presence of coastal fog. As one moves northward along the Pacific Coast, pollinator activity decreases and along with it total species abundance (79 solitary bee species at Torrey Pines,

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$$H = -\sum_{i=1}^{S} (\text{relative abundance}_i)(\ln \text{relative abundance}_i)$$

42 species at Point Reyes).

Unlike alpine environments, in which the total growing season for perennials is severely limited, many species of self-incompatible coastal perennials (e.g., Lupinus arboreus, Mesembryanthemum chilensis, Eriophyllum staechadifolium, Eschscholzia californica) are able to set outcrossed seed in this pollinator-poor environment by extending the period of anthesis nearly year-round. Annual plants, abundant under the canopy of the coastal scrub, respond to the perpetual lack of pollinators by the evolution of cleistogamy and obligate selfing; 10% of the coastal flora is cleistogamous while only 5% is cleistogamous in the chaparral. Showier flowers are required even for limited outcrossing in coastal exposures, where pollinators are limiting (e.g., Epilobium watsoni, Oenothera hookeri, Amsinckia spectabilis, Plagiobothrys reticulatus, Orobanche grayana var. violacea, Mimulus guttatus var. grandis) than are required by closely related taxa in the chaparral where heavy outcrossing can be achieved with minimal floral size.

Offshore pollination has been studied at the Farallon Islands (Moldenke 1971 and 1975). Nesting oceanic birds (e.g., Larus occidentalis) utilize every scrap of vegetation and flotsam for nest-building; therefore, the flora is restricted to annual plants which must bloom and produce mature seed prior to the gull nesting season beginning in late April. During this period, drizzle and strong winds are frequent. The usual pollinator groups are entirely absent except for one species of migratory butterfly (Vanessa cardui) and an abundant hoverfly. All the native species and successful introductions are genetically compatible and selfing is the usual method of reproduction for all of them. The beaches and surrounding rocky ridges are inundated with "clouds" of seaweed flies (Fucellia evermanni); some of these flies visit the flowers of Spergularia macrotheca and Lasthenia minor ssp. maritima and may vector pollen between individuals. Along the immediate mainland coast L. minor is self-compatible, but it is outcrossed by locally frequent but unpredictable vector species (the largest, blackest, and hairiest of the specialist pollinators, Andrena chlorosoma, in particular). Lasthenia species of the interior grasslands are genetically incompatible and heavily visited by specialists as well as generalists. However, on the offshore islands, pollinators are virtually absent and L. minor has nearly lost its attractive ray florets and is generally self-pollinated before the disc florets have

opened. Lasthenia glaberrima of the marshes has also lost its ray florets and incompatibility in the absence of its normally abundant bee pollinators (Ornduff 1966).

COMPARATIVE FEATURES OF POLLINATOR AVAILABILITY

No instances within the California flora are documented in which the distribution of a plant species is limited by absence of a suitable pollinator. Nevertheless, over long periods of time the relative abundance and diversity of different pollinator groups must exert a major effect on the success of various plant taxa. Table 3 presents the results of my own studies on the relative abundance of pollinator types in 19 California plant communities.

Bees are the most diverse group of pollinators in all the communities studied except the subalpine marsh-meadow (36 species per 0.5 km^2), where anthomyiid flies are most diverse. Anthomyiid flies are as diverse in the other subalpine communities (ca. 45-55 spp.), but bee diversity is proportionately even more diverse (ca. 70-90 spp.). Bee species count reaches its highest levels in low elevation and mid-elevation grassland chaparral and open forest communities (140-170 spp. per 0.5 km^2). Bees generally outnumber (by individuals) all other pollinator groups at the sites; however, beetles are the most abundant groups in chaparral (Stanford and Mather), oak-woodland (Stanford) and montane grassland (Mather) while anthomyiid flies and sawflies outnumber bees in subalpine meadows and forests. Butterflies are most abundant in grasslands (ca. 25), chaparral (ca. 25) and subalpine talus (ca. 50); they are very infrequent in desert (4 spp.) and the coastal sage (3 spp.) of northern California. Beeflies average about 20-30 spp. per o.5 km^2 throughout California, but are very reduced throughout elevations above 2,000 m, the immediate coast and forest communities. Beefly abundance is highest in chaparral and grassland communities, reflecting the extreme abundance of Conophanus on Lasthenia, Geron on Eriogonum and Phthiria on Ceanothus. Syrphid fly diversity averages 15-17 spp. per 0.5 km^2; generally reduced levels are found throughout the southern transect and specific reductions are observed in subalpine marsh-meadow and mixed evergreen forest. Hoverflies are most abundant in serpentine and mid-elevation grasslands and mid-elevation chaparral. Eupeodes volucris, a generalist, is an extremely important pollinator of the early spring Colorado Desert ecosystem. Wasps are abundant flower visitors in many California communities (except for alpine and coastal regions) and characteristically demonstrate the highest diversity levels in Mediterranean

and desert scrub. Hummingbirds and sphinx moths are undiverse throughout all California; they occur in highest abundance in the chaparral and talus scrub communities, where deep tap-rooted shrubs provide them with the most predictable resources.

Hummingbird, sphyngid and bumblebee abundance is subject to extreme fluctuation seasonally and annually. Hummingbirds and the most abundant sphyngids are migratory; they are limited to the spring season in desert regions, building up to their highest abundances in the alpine communities by late summer. Bumblebees are variable in abundance in all regions; factors controlling their abundance have not yet yielded to analysis.

Total pollinator diversity is highest in scrub communities in all locations, generally 25%-33% higher than grasslands. Diversity is cut by 50% in coastal communities (ca. 105 spp. per 0.5 km^2) from that observed in adjacent chaparral. Diversity plummets in arctic-alpine and mixed-evergreen forest to a low of ca. 70 species. Pollinator abundance is highest at Mather ($\bar{X}$ = 230,000 km^{-2}), drops slightly at Stanford (160,000 km^{-2} discounting evergreen forest) and then precipitously to 46,000 km^{-2} at San Diego, 21,000 km^{-2} at Point Reyes, 18,000 km^{-2} at subalpine Tioga Pass, 12,000 km^{-2} in mixed-evergreen forest and 3,500 km^{-2} in the arctic-alpine. Within the limits of confidence imposed by our estimates of biomass, most communities support rather similar levels of pollinator biomass; biomass is highest in the Mather chaparral (by a factor of 2x), drops by a factor of 50% in subalpine forest and San Diego coastal sage and 90% in subalpine marsh-meadow and mixed evergreen forests.

Since bee species participate in the pollination of more than 95% of the insect pollinated plants of California, it is especially important for entomologists to

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TABLE 4. Distribution of bee groups in Biotic Regions of California.
Total number of specialist-feeding bee species and number of resident plant genera associated with specialists is indicated. Total specialist bee species is highest in desert regions, though total bee species is highest in cismontane southern California. Different bee families have evolutionarily radiated to a differential extent within the different biotic realms. All numbers represent our best approximations based on the data summarized in Moldenke and Neff (1974).

Table 4.	Colletidae	Andreninae	Panurginae	Melittidae	Halictidae	Megachilidae	Anthophoridae	Apidae	Total Bee Species	Plant genera with specialist pollin.	Total specialist bee pollinators
TRANSMONTANE											
Northern Great Basin	13	30	12	0	21	72	50	15	213	17	118
Great Basin	12	18	12	0	19	66	47	5	179	14	98
Owens Valley	21	22	86	6	48	120	84	7	394	33	253
DESERT											
Mojave Desert	29	29	101	9	80	105	103	1	456	33	271
Colorado Desert	27	22	137	14	86	92	104	0	482	35	299
MONTANE											
Trinities and Siskyous	17	43	0	0	21	80	46	13	220	11	86
Alpine Sierras	15	18	4	0	25	87	20	14	183	13	89
Northern Sierras	23	70	15	0	62	137	81	10	398	28	170
Southern Sierras	20	80	25	2	96	170	116	7	516	38	219
Montane and alpin So. California	12	53	20	3	95	146	85	8	422	30	186
COASTAL											
Dunes and Sage	10	30	3	1	43	24	41	10	172	12	52
MEDITERRANEAN											
No. Coast Ranges	16	60	9	0	61	114	106	11	377	33	152
So. Coast Ranges	21	96	40	2	89	132	132	8	520	44	262
Cismontane So. California	22	98	43	7	122	119	138	7	555	47	253
Northern Central Grassland	13	48	9	0	41	45	72	10	238	29	108
Southern Central Grassland	19	84	30	1	57	54	80	7	282	36	161

document their pattern of geographical distribution. Table 4 shows that the highest diversity of bees is associated with arid and semiarid regions (data taken from Moldenke and Neff 1974). Though faunal species diversity is highest for desert regions, most species are infrequently encountered yielding the characteristic pattern of low species diversity within 0.5 km^2 areas observed in the Colorado Desert, Sonoran Desert and the Atacama (Moldenke and Neff, in press); species encountered are often in high abundance. Bee diversity is lowest along the immediate coast, the high Sierra Nevada, the rainforests of northern California and the Great Basin (the latter two regions have been very poorly collected and studied and these areas may be under-represented). Specialist coevolved bees are most abundant in desert, grassland and chaparral communities; generalists most abundant in coastal, forest and alpine communities. Table 5 records our present knowledge of the host associations and distribution of specialist pollinators (Moldenke and Neff 1974).

POLLINATION CHARACTERISTICS OF THE CALIFORNIA FLORA

Data collected from a cross-indexing of Moldenke and Neff (1974) which includes all host data on bees in California insect collections and the results of the first five years of our own community pollination research is presented in Figure 1. Plant species exhibit a wide range of success at attracting pollinators, as measured either by total number of vector species or total number of vector individuals. These data points are not robust, but they are all that is available. Relative position on the graph is undoubtedly a true portrayal for nearly all the genera listed, but the numbers are not particularly meaningful and should not be thought to indicate significant differences between plant genera located within similar portions of the curve.

FIGURE 1. Abundance and diversity of Bee Pollinators of California Plant Genera.
Figures represent a cross-indexing of all documented records of bee flower visitation presented in Moldenke and Neff (1974) and all of my own subsequent studies (Moldenke 1976 and unpublished). Numbers refer to generic designations cited in Appendix and represent the 44 most abundantly bee-pollinated genera in California. The 133 genera poorly pollinated by bees are too dendely clustered to represent separately; the symbol X denotes several separate genera with the same abundance of vector species and individuals. Therefore, 343 genera of California are without documented native bee pollinators.

Vector species
10
100
Vector individuals
10
100
1000
10,000
133
223
44
612
240
593
287
299
114
42
74
315
63
249
569
72
517
312
374
163
706
135
254
300
592
650
313
164
124
417
247
572
397
655
411
431
198
17
645
197
160
611
305
413
375
530
248

Figure 1.

Regretably, I know of no manner in which this data can be correlated to plant abundance or relative floral biomass on a state-wide scale since no relevant censuses or reliable estimates exist. Many plants with the highest visitation rates are not abundant plants, and as such represent "cornucopia species" (e.g., Phacelia, Rhamnus, Eriodictyon, Lotus, Cirsium, Clarkia, Penstemon and Sphaeralcea). These heavily visited taxa represent less than 9% of the tabulated flora and a mere 4% of the entire entomophilous California flora; their uniqueness remains to be examined in quantitative and qualitative chemical nutritional terms.

Figure 1 demonstrates that 133 of the tabulated insect-pollinated genera are very poorly pollinated by bee taxa. More than 75% of these taxa are not pollinated by other types of pollinators and are self-compatible (or suspected of being so) and most appropriately should be treated as habitual selfers. Thus a total of about 25% of the chasmogamous nonwind-pollinated genera of California is clearly unsuccessful in competition for pollinators. Within this group of losers there are two clear components: (1) compatible taxa which compete evolutionarily by inbreeding population dynamics and short life cycles; (2) incompatible perennial taxa which can balance low visitation rates by long life cycles. This dichotomy should be apparent in the nutritional characteristics of the nectar produced.

Ten taxa display a disproportionate number of increased abundance of vector individuals relative to total vector species. The great success of relatively few taxa upon a particular floral resource implies that the resource may be difficult for generalists to utilize, but that successful exploiters are able to build up to very large populations in the absence of competition. Three of these species bloom considerably before bee diversity is apparent (e.g., Arbutus, Cynoglossum and

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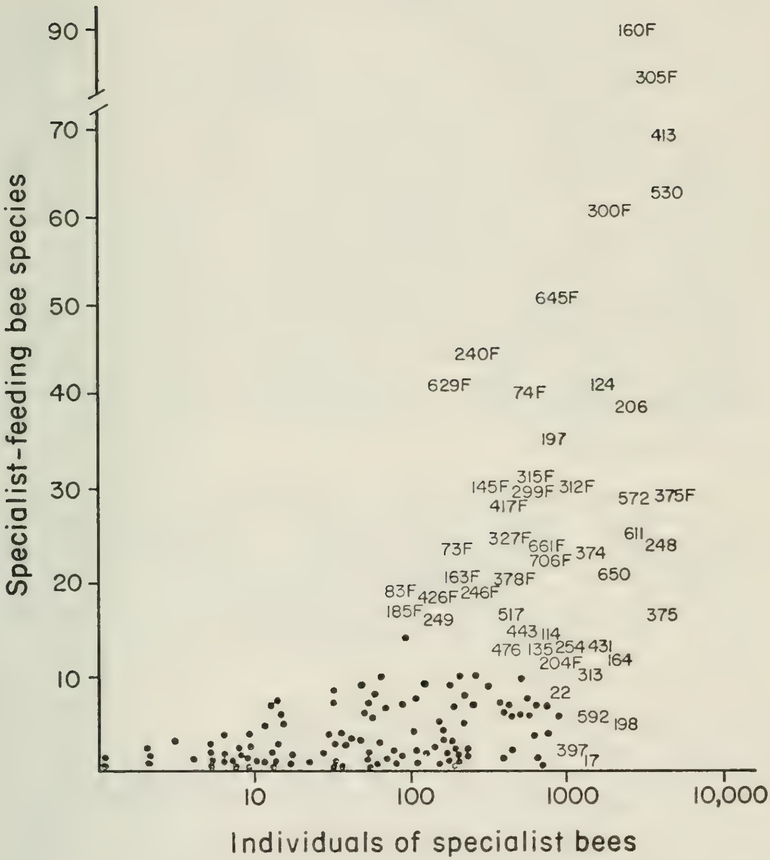
FIGURE 2. Abundance and Diversity of Specialist Bee Pollinators of California Plant Genera.
Figures represent a cross-indexing of all documented records of specialist bee flower visitation presented in Moldenke and Neff (1974) and my own subsequent studies (Moldenke 1976 and unpublished data). Numbers refer to generic designations used in the Appendix. The suffix "F" denotes the inclusion of all "Family-specific" bee visitors (in addition to those which may be generically limited) which have been documented to visit the particular genus in question. Note the extensive differences in relative abundances of specialist-feeding bees.

Figure 2.


Specialist-feeding bee species
Individuals of specialist bees
160F
305F
413
530
300F
645F
240F
629F
74F
124
206
197
315F
145F
299F
312F
572
375F
417F
327F
661F
611
248
73F
706F
374
163F
378F
650
83F
426F
246F
185F
249
517
375
443
114
476
135
254
431
204F
164
313
22
592
198
397
17

Zigadenus), one genus requires special morphological adaptations for pollen collection (Coldenia) and two others bloom only in the early morning (Anisocoma and Cucurbita).

Twenty-two of the thirty-five California plant genera visited by the largest number (more than 20 species or more than 1,000 individuals with at least 10 specialist species) of specialist pollinators are composites or legumes (Figure 2). Most of the specialist pollinators of these genera are specific only to the family level, visiting any synchronously blooming species in the appropriate family. These high abundances of specialist pollinators, distributed widely throughout the entire state afford these two groups with an enormous advantage in their reproductive ecology. Character displacement of the anthesis times of congeneric sympatric plant species would be expected to evolve to facilitate greatly the efficiency of pollination systems utilizing specialist feeding bees which are seldom restricted more narrowly than the generic or subgeneric level. The other plant genera associated with large numbers of specialists are: Lasthenia, Prosopis, Larrea, Camissonia, Malacothrix, Salix, Clarkia, Eriogonum, Phacelia, Heliotropium and Sphaeralcea (Figure 2).

WIND POLLINATION

Wind pollination is the predominant mode in 18% of the California genera, most (79%) of these fall within the Graminae, Cyperaceae, Juncaceae, Gymnospermae, Amaranthaceae, Chenopodiaceae and Compositae (Ambrosiae). Only Garrya is unrelated to wind-pollinated forms in other regions and seems to be endemic to western North America; other monogeneric wind-pollinated groups are

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TABLE 5. Host-associations and Distribution of Specialist-Feeding Bees in California.
Data cited are based on the preliminary studies of Moldenke and Neff (1974). It must be recognized that they represent low estimates, for future studies will undoubtedly elucidate more instances of specialization, and many generalist-feeding taxa will be shown to have specialist-feeding geographic races which have not yet been discovered. Figures in parentheses are species which, though polylectic, heavily emphasize pollen collection from the genus in question whenever it is available. Tabular symbols * and · represent respectively the possibility of one and two additional specialist bee species, but sufficient corroborative data is lacking presently.

Table 5.	Northern Great Basin	Great Basin	Owens Valley	Mojave Desert	Colorado Desert	Trinities and Siskiyous	Alpine Sierras	Montane No. Sierras
Abronia				1	1			
Adenostoma								
Agave					1			
Amsinckia								
Arctostaphylos	1(1)	1(1)	1(1)			2(1)		3(1)
Arenaria								
Argemone			(1)	1	1			
Cactaceae			5	6	8*			
Calochortus	1	1	4*	1		1		1
Calystegia								
Camissonia	2(*)	1(*)	2(*)	17(*)	14			1
Capparidaceae			5(*)	4(*)	1(*)			
Ceanothus	1(3)	(2)	(1)			(1)		3(3)
Cercidium/Olneya				(4)	1(13)			
Clarkia	3							5
Coldenia					11			
Collinsia			1					1
Compositae	49	48	72*	67*	61*	30	26	42*
Compositae	(3)	(4)	(4)	(3)	(3)	(4)	(4)	(6)
Cordylanthus								
Cowania			1*					
Croton				1	3			
Cryptantha	2	1	7	11	6			2
Cruciferae								
Cucurbita		1	3	4	3			
Dalea			11*	9(1)*	12(2)*			
"Dandelions"	3	3	10	7	6			2
Delphinium								
Dicentra								
Dentaria								
Emmenanthe								
Eriastrum			1	1(1)	1			
Ericaceae							1	
Eriodictyon								2
Eriogonum			5	10	11			1
Eschscholzia			2	5	4(1)			
Eucnide			1					
Euphorbia				3	7			
Hackelia							(1)	
Heliotropium			1	1	1			
Jepsonia								
Larrea			8(4)	14(5)	14(4)			
Lasthenia								1
Layia								
Leguminosae	14	11	16*	12*	13	14	15	19
Leguminosae	(9)	(6)	(4)	(3)	(3)	(8)	(3)	(18)
Lepechinia								
Lepidium			1	1	1			
Lesquerella					1			
Limnanthes								1

Table 5.	Montane So. Sierras	Montane So.California	Coastal	No. Coast Ranges	So. Coast Ranges	Cismontane So.California	No. Central Valley	So. Central Valley
Abronia								
Adenostoma	1	2(1)			2(1)	2(2)		
Agave								
Amsinckia				(1)	(1)	2	1(1)	1(1)
Arctostaphylos	4(1)	3(1)		2(1)	2(1)	2(1)		
Arenaria							1	1
Argemone								
Cactaceae			1			1		
Calochortus	3*	3		1	5	3	1	4
Calystegia	1			1	1	1	1	1
Camissonia	1	2	7	1	7	15	2	10
Capparidaceae								1
Ceanothus	5(3)	5(3)	1(2)	3(3)	3(4)	7(4)		
Cercidium/Olneya								
Clarkia	7	3		4(1)	7(1)	3(1)	2	4
Coldenia								
Collinsia	1			1	1			1
Compositae	44*	47*	14	34*	45	44	33	32
Compositae	(5)	(6)	(2)	(4)	(9)	(6)	(5)	(6)
Cordylanthus				(3)	(4)	(4)		
Cowania								
Croton								
Cryptantha	7	4		1	4	11*	2	3*
Cruciferae						1	1	2
Cucurbita						3	1	2
Dalea								
"Dandelions"	3	2		1	7	5(1)	2	6
Delphinium	1					1	1	1
Dicentra		1			1	1		
Dentaria				(1)				
Emmenanthe					2	1*		
Eriastrum					(2)			
Ericaceae								
Eriodictyon	4(1)			2(1)	4(2)	5(1)		
Eriogonum	2	2		2	4	6	1	6
Eschscholzia	3	4	1	3	6	7	2	9
Eucnide								
Euphorbia							1	2
Hackelia								
Heliotropium					2	1	1(1)	3(1)
Jepsonia	(1)							
Larrea								
Lasthenia		1	3	2	6	7	9	9
Layia		1	1			4	2	2
Leguminosae	26	27*	5	18	24*	17	11	13
Leguminosae	(17)	(17)	(5)	(7)	(19)	(17)	(4)	(6)
Lepechinia					1	1		
Lepidium								
Lesquerella								
Limnanthes	1				1	1	1	1

Table 5.	Northern Great Basin	Great Basin	Owens Valley	Mojave Desert	Colorado Desert	Trinities and Siskiyous	Alpine Sierras	Montane No. Sierras
Linanthus	1			1	1			3
Lycium					2			
Malacothamnus								1
Meconella								
Melilotus								
Mentzelia			3*	6*	8(1)			
Mertensia		1					1	
Mimulus	1		1					2
Monardella								
Nama			1	5	6			
Nemophila								2
Orthocarpus								
Penstemon	2*	1	5			2(1)	6	4(1)
Perideridia								
Petalonyx				1	1			
Phacelia	6	7	16*	17	15	6	9*	11
Phacelia	(1)	(1)	(1)			(2)	(4)	(3)
Physalis				1	2			
Platystemon								
Proboscidea				1	1			
Prosopis			12(2)	15(2)	23(3)			
Potentilla			2				5	2
Psoralea								
Ranunculus						5	1	4
Rhamnus								
Ribes								1
Rosaceae	1					1	2	1(2)
Salix	5*	4	3	3	3	7	3	8
Salvia			1					
Sidalcea								1
Sphaeralcea			12	14*	17*			
Stachys								
Stephanomeria				2	3			
Symphoricarpos	1	1	1					
Trichostema								
Trifolium	3	2	2	1			3	4
Umbelliferae						1	1	2
Zigadenus								

Table 5.	Montane So. Sierras	Montane So. California	Coastal	No. Coast Ranges	So. Coast Ranges	Cismontane So. California	No. Central Valley	So. Central Valley
Linanthus	3	2		2	2	6*	1	1
Lycium								
Malacothamnus	2	2		1	3	2	1	2
Meconella					1			
Melilotus								1
Mentzelia								
Mertensia								
Mimulus	4				1			
Monardella	1	2			1	1		
Nama								
Nemophila	4	6		3	5	3	3	3
Orthocarpus					(1)		(1)	(1)
Penstemon	6(1)	6(1)		1(1)	2(1)	1		
Perideridia	1							
Petalonyx								
Phacelia	18*	12	3	11	17	18*	7	10
Phacelia	(2)	(2)		(1)	(4)	(2)		(1)
Physalis								
Platystemon					6	3*		
Proboscidea								
Prosopis								
Potentilla	3	2						
Psoralea					1			
Ranunculus	3	3	2(1)	4	3	2	2	2
Rhamnus		2			2	3		
Ribes	1	1*		1				
Rosaceae	1(2)	1		(1)	(1)			
Salix	8	5		6	7	8	2	5*
Salvia					1	1		
Sidalcea	2			1	2	2		
Sphaeralcea								
Stachys				(1)	(1)	(1)		
Stephanomeria	1	1			2	2		1
Symphoricarpos								
Trichostema	(1)			(1)	(1)	(1)		
Trifolium	4	1		3	3	2	2	2
Umbelliferae	1			3	2	2	2	3
Zigadenus	2				2		1	2

either widespread in adjacent regions or relicts of formerly much wider distribution (e.g., Empetrum, Forestiera, Simmondsia, Thalictrum, Batis, Oligomeris, Eremocarpus, Tetracoccus, Datisca).

Wind pollination is the dominant form of pollination in all California forest and grassland communities. In these communities the dominant plants, with the largest relative biomass of flowers, are all wind-pollinated. Species composition of communities reveals a low of 10% wind pollination in chaparral ecosystems (generally confined to the herb stratum), to a high of 35% in the subalpine marsh-meadow, with most communities averaging about 15%-22% anemophily in the flora. An average of 27% of the flora at subalpine and alpine localities is wind-pollinated; this percentage drops to 18% at altitudes of 1,300 m and sea level as the general abundance of insect pollinators increases.

WATER POLLINATION

The only documented examples of water pollination in the California flora that I am aware of involve species in the Zosteraceae, Zannichelliaceae, Ruppiaceae and Najadaceae. In all cases, except for Ruppia, water pollination is associated with unisexual flowers. These are all very widely distributed plant genera and their pollination adaptations (Faegri and van der Pijl 1966) are not unique to our region.

HABITUAL SELFING

Eighteen percent of the genera of angiosperms in California are habitual or obligate selfers (not counting any "wind-pollinated" selfers). Most of these genera are in families composed predominantly of small annual plants, many of which are habitual selfers (e.g., Cruciferae, Caryophyllaceae, Boraginaceae, Portulacaceae, Compositae [Inulae]). A large percentage of them are endemic to California and adjacent regions and presumably evolved locally; this particular method of estimating the endemicity of selfing taxa yields a low estimate, since many normally chasmogamous genera have evolved individual selfing species on numerous occasions in California (e.g., Astragalus gambellianus, Lupinus micranthus, Lotus micranthus). Predominantly selfing genera that have speciated the most noticeably in California are those which are visited occasionally by pollinators (e.g., Cryptantha spp., Eriogonum spp.). Inbreeding population dynamics of themselves does not seem to have noticeably increased evolutionary rate within the California flora though many of the most

diverse genera are genetically compatible (e.g., *Mimulus*, *Gilia* *s. lato*, *Potentilla*); all of these genera are frequently cross-pollinated.

Habitual selfers are most abundant in grassland communities (41%-42% of the flora at Stanford and Camp Mather--Table 2). Relatively high levels of habitual selfing are also found in the annual forbs of the immediate coast (ca. 30% of flora); the subalpine talus (35%), the desert annuals (38%) and the arctic-alpine (39%). Obligate selfing constitutes approximately 5% or less of the flora in all communities, except for high levels in the serpentine grasslands (18%), coastal sage (9%-11%) and subalpine talus (8%). High levels of selfing and obligate selfing are found, of course, in both the weedy and offshore island communities. Habitual and obligate selfing is correlated to annual habit and often associated with climatic conditions under which pollinators are either consistently lacking or periodically in very low abundance. In grasslands, where pollinators are often abundant, obligate selfers are species which bloom before the period of activity of the pollinators. At Jasper Ridge, pollinator diversity and biomass starts to rise noticeably during the first week of April; by this time 68% of the 27 obligate selfers have already nearly finished blooming. The selective pressures forcing such an early period of anthesis upon so many unrelated plants must remain speculative.

BEE POLLINATION

Of all the forms of animal vectored pollination, pollination by bees is the most significant in all communities based upon the percentage of the flora so dependent (Table 2; Appendix). Bees visit nearly every type of nonwind-pollinated flower morphology, excluding perhaps only some of the more highly modified hummingbird, moth and fly forms. Bees may function as locally important pollinators to seldom-visited plant species because of the plumose pubescence (to which pollen readily adheres) and their strong behavioral tendency to visit the same plant species on subsequent visits. The most generalized opportunistic bee feeders (bumblebees in forest, coastal and alpine communities; halictines in Mediterranean climates and open forest understory) are undoubtedly the most significant outcrossers of plant species in very low abundance or locally common species with inconspicuous flowers and rather low reward levels per flower. These generalist bees function as the most significant pollination element in California, since in addition to their pollen vectoring for the 86% of the genera on which other vector agencies have not been

recorded in Table 1, they efficiently service nearly all the angiosperm genera frequently visited by other sorts of pollinators (including specialized solitary bees). The percentage of the flora they service in any community is a close approximation to the total flora minus the wind-pollinated forms and obligate selfers. Both bumble and halictine bees are extremely significant in the pollination of introduced weedy plants, since the new introductions are either ignored by the native pollinator fauna in native surroundings or all other groups of pollinators from heavily disturbed situations.

Halictine bees serve as the primary or sole vector for a rather small percentage of the flora (ca. 5%) in all but the chaparral, talus scrub and grassland communities where they assume a much more significant role (ca. 15%). In the subalpine marsh-meadow and desert communities they are seldom the principal vectoring agency for any plants whatsoever. Bumblebees serve as the primary or sole pollinating agency for a much more variable percentage within differing plant communities. They are nearly absent from San Diego County and the desert regions and do not function as exclusive vectors for any plant species whatever. In coastal, montane, alpine or dense forests the percentage of the flora served primarily by their agency rises generally to more than 20% (a high of 47% in coastal communities).

Solitary bees as a group are the most interesting. Time and time again, coevolutionary relationships have been established between specialist-feeding bees and particular host plants. Community analyses have shown (Table 2) that solitary bees are a primary pollinator for an average of 12% of the flora at Point Reyes, 20% at Tioga Pass, 34% along the San Diego County transect, 42% at Stanford University (excluding deep forest), and 51% at Camp Mather (excluding forest). The percentage of plants serviced by specialist solitary bees follows similar overall site trends but is characterized by a noticeable drop in all forest communities and a peak in chaparral scrub and desert communities. It is a frequent occurrence to observe several species of obligately specialized bees on local populations pollinated exclusively by their agency.

BEEFLY POLLINATION

Beeflies (Bombyliidae) serve as the primary pollinator for 10%-20% of the resident flora in low to middle elevation central California community types; they are insignificant elements in the alpine communities and drop in relative importance (though not abundance) in the

communities of southern California. The Compositae (associated with the short-tongued genera Anthrax, Conophorus, Conophanus, Exoprosopa, Poecilanthrax and Villa) and the Boraginaceae and Polemoniaceae (associated with the long-tongued genera Bombylius, and the smaller-bodied Oligodranes, Geron, Phthiria) are often intimately associated in close coevolutionary patterns (Grant and Grant 1965). Many of these insects are inquiline parasites on solitary bees as larvae and will be found primarily in regions of large solitary bee abundance; the smaller species are often parasites of grasshopper egg cases. Long-tongued beeflies often hover in front of the flower while feeding and, as such, pollen transfer must be limited to pollen adhering to the proboscis (e.g., Cryptantha). Many members of the Polemoniaceae have strongly exerted anthers and stigmas which contact the hovering insects as they probe the long tubes for nectar. Though many species are "apparently" morphologically adapted for sipping nectar only, most species are suspected of being major pollen consumers as well (A. Moldenke, J. Neff, J. Hall, unpub. observations).

Seventy-three genera of California plants are frequented by beeflies and the closely related spider predators, the Acroceridae (Cyrtidae). Acrocerids have immense non-retractile slender proboscises, sometimes nearly twice the length of the body. Acrocerids are often the major or sole pollinators of Azalea, Brodiaea, Calystegia, Diplacus, Iris and Monardella populations; they also frequent Clarkia, Cryptantha, Eriogonum, Linanthus, Penstemon, Salvia and Wyethia in significant numbers along with other pollinator groups as well. Bombylius major is a species associated with forest understory communities and exerts a major role in the pollination of 20 genera of plants in these localities and along the immediate coast as well (e.g., Arbutus, Arctostaphylos, Cakile, Collomia, Cynoglossum, Dentaria, Fragaria, Hackelia, Lithophragma, Smilacina, Solanum and Viola). Other species of the genus, and B. major to a lesser extent, are the major pollinators of grassland and desert Polemoniaceae, Boraginaceae, Centaurium and Petalonyx. Of the many genera of fall composites heavily visited by the generally short-tongued Tomophthalmae, all are visited by numerous other vectors as well. Even though visited by numerous solitary bees, Lasthenia is so heavily visited by the genera Conophanus and Conophorus that they must play a very significant role in its reproductive ecology. Few plant genera are obligately dependent upon the vectoring afforded by the tiny Phthiriinae, Gerontinae and Usiinae; Allophyllum, Calycoseris, Kelloggia and Nemacladus are

the most closely tied. All of the non-forest genera relying upon beefly pollination are genetically compatible and capable of selfing in their absence.

HOVERFLY POLLINATION

Less than 5% of the flora within all the California communities we studied relies upon the exclusive pollination of hoverflies (Syrphidae). All of these taxa are small-flowered annual plant species which would self in the absence of hoverflies and may be outcrossed most frequently by halictine bees at other sites. No instances of close coevolutionary relations between California plants and hoverflies are known to me. In the weedy community, the tiny hoverflies (Paragus, Allograpta) visit many nearly cleistogamous species and may play a significant role in the genetic recombination of these weed species; syrphids seldom have much facial pubescence and hence may not vector pollen as frequently as their abundance upon flowers might indicate.

"FLY" POLLINATION

Various other fly groups assume importance only in rare circumstances. Anthomyiid pollination is pronounced only in subalpine regions (16% of the forest and marsh-meadow flora necessitating their vectoring, 8% of the talus community). Flesh-fly pollination has evolved with Scoliopus and is reported for Bebbia, but I doubt its general significance in the latter case. Bebbia may be found in bloom nearly 12 months of the year; usually it is heavily visited by butterflies and composite-associated solitary bees. Coelopid fly pollination is an unstudied possibility in estuarine marshes and offshore islands, presumably no plant not normally self-pollinating relies heavily upon their visitation. Mycetophilid pollination is known only in the Aristolochiaceae in California (Vogel 1973); since this is the general pattern for the family, little special coevolutionary adaptation apparently has occurred in California. Mosquitos (particularly males) are extremely inefficient pollen vectors, but may exert an outcrossing effect for the normally self-pollinated genera, Habenaria and Sambucus; in more northerly distributions of these taxa, the vectoring by mosquitos becomes much more frequent (i.e., Stoutamire 1970). Heuchera and Arceuthobium (Stevens and Hawksworth 1970) rely exclusively on gnat pollination; these adaptations also are ancient adaptations and not uniquely characteristic of the California flora.

WASP POLLINATION

Forty genera of plants in California are frequently visited by sphecoid and vespoid wasps although only 24 are visited consistently, regardless of local circumstances.[d] Plant species relying heavily upon wasp pollination are infrequent throughout California (less than 3% of the resident flora locally, reaching highest levels in chaparral and desert communities [ca. 5%]). The importance of wasps in the pollination of Cryptantha and Eriogonum depends upon the local abundance of more efficient pollen vectors, but Antennaria, Gnaphalium Cuscuta, Achillea and Baccharis are generally heavily outcrossed by their agency. Scoliid wasps (e.g., Campsomeris) are important pollinators of Mesembryanthemum chilensis both in California and Chile. Asclepias is primarily pollinated by large tarantula-hawks (Pompilidae), especially in more southerly locations. The related mimosoid genera Prosopis and Acacia are heavily visited by diverse wasp groups; the latter is primarily wasp pollinated, whereas the former is a cornucopia exploited by many groups of pollinators. Wasps are never associated with papilionaceous flowers except for Maricopodynerus which is a specialist on Dalea (R. Snelling pers. comm.). The extremely abundant social wasps of the tropics (i.e., Mischocyttarus) which visit flowers in enormous abundances are not found associated with flowers in California.

Only the masarid wasps (Pseudomasaris spp.) utilize floral resources as the sole provision for the young in a dependency closely analogous to bees. Pseudomasaris vespoides is specific to Penstemon, while the other species frequent specifically Phacelia and Eriodictyon. Though the flora may not have coevolved with a reciprocal dependency, this diverse genus is distributed only in Madro-Tertiary regions of western North America (Torchio 1975).

The primitive sawflies (Tenthredinidae) are important pollinators of Nemophila, Phacelia, Polygonum bistortoides, Salix, Sambucus and Valeriana. Except for the hydrophyllaceous genera, these genera are closely associated with sawfly pollination throughout alpine western North America.

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[d] Consistently visited taxa: Acacia, Achillea, Asclepias, Baccharis, Chrysothamnus, Cryptantha, Cuscuta, Encelia, Eriodictyon, Eriogonum, Eriophyllum, Euphorbia, Haplopappus, Helianthus, Lepidospartum, Perideridia, Prosopis, Salix, Solidago, Sphenosciadium, Viguiera, Wislizenia.

BEETLE POLLINATION

Beetle pollination is a poorly studied and diverse phenomenon. Nearly all species of California plants in which beetles play a significant role in pollination are visited by additional vector types as well (see Appendix). Hence, no specific morphological floral adaptations for beetles has evolved. Tumbling flower beetles (Mordellidae) are very important pollinators of the Umbelliferae and mass-blooming Rosaceae. Long-horned wood-borers (Cerambycidae) are important pollinators of _Ceanothus_, _Ranunculus_, the Melanthaceae, _Sambucus_, _Achillea_, and other tight inflorescences of small white flowers. Metallic wood-borers (Buprestidae) are important pollinators of yellow flowers or inflorescences in the early spring (i.e., _Ranunculus_, _Camissonia_, _Eriophyllum_, _Wyethia_). Many other beetle groups commonly found on flowers probably cause more destruction by their feeding than their use as vectors can compensate (i.e., Meloidae, Dermestidae, Chrysomelidae). I have consistently been unable to find evidence of beetle pollination in _Paeonia_ and _Calycanthus_ (Grant 1950); the former is a heavy selfer facultatively outcrossed under most circumstances by solitary bees of the genus _Andrena_.

BUTTERFLY POLLINATION

Plants that have coevolved specifically for pollination by butterflies are rare in the California flora (see Appendix). _Verbena_ (_Glandularia_) and _Phlox_ are widespread groups dependent upon butterfly pollination throughout their range. Most genera of the Compositae are pollinated by butterflies as well as many other groups of vector taxa. Abundant individuals of _Danaus_, _Colias_ and _Pieris_ are important pollinators of their host plants (Asclepiadaceae, Cruciferae, Capparidaceae, and Leguminosae). Butterfly pollination is most frequent in open chaparral and grassland communities. In alpine ecosystems many moths, unable to fly under the prevailing cold nighttime conditions, visit inflorescences primarily of the Compositae during the daytime. At lower elevations, the moth genera _Adela_ and _Schinia_ are abundant daytime pollinators in grassland and open forest habitats. A catalogue of published butterfly floral visitation records is available (Shields 1972), but since the catalogue does not distinguish between rare instances of visitation and consistent fidelity to a plant group, the information is difficult to interpret.

MOTH POLLINATION

Moth pollination (except for sphinx pollination, which is more properly treated below) is poorly studied and little developed in California. Moths visit the flowers of many white-flowered plants at night; however, most of them have already been fully pollinated during the day. With the exception of some species of _Phlox_, _Silene_, _Gaura_, _Madia_, and _Chlorogalum_, I suspect that noctuid or geometrid pollination is insignificant for California plants. The remarkable coevolutionary relations between moths and Yucca discovered by Riley (1892) and reviewed in detail by Powell and Mackie (1966) are unique to western North America. _Gaura_ and _Clarkia breweri_ (MacSwain _et al_. 1973) are onagraceous plants which are usually moth-pollinated; the former is widely distributed throughout arid North America. _Madia elegans_ and _Chlorogalum pomeridianum_ are species which open in the late afternoon presumably as a response to selection for moth pollination; these species are frequently heavily visited by bees prior to darkness, at which time the moths become active.

SPHINX AND HUMMINGBIRD POLLINATION

A more frequent and closer dependency is exhibited between sphinx moths and native plants. Ten genera have coevolved with these high-energy requiring facultatively homeothermic pollinators (e.g., _Aesculus_, _Abronia_, _Aquilegia_, _Azalea_, _Chlorogalum_, _Datura_, _Hesperocallis_, _Mirabilis_, _Nicotiana_, _Oenothera_)although sphinx moths are pollinators for many other genera as well. Species in the genera _Aesculus_,_Aquilegia_, and _Azalea_ have been documented to utilize sphinx moths to transfer pollen only in the western United States, and presumably this trait is locally evolved, as in the case for _Abronia_ (Tillett 1967), _Chlorogalum_ and _Hesperocallis_, which are endemic to arid or semiarid western U.S.A. In many localities, sphinx moths are active during the day; they closely resemble hummingbirds and indeed visit many of the same plant species.

Thirty-nine genera are pollinated by hummingbirds and have evolved extensive morphological adaptations to effectively exclude other types of pollinators and

produce better visibility to the hummingbirds.[e] Hummingbirds are important pollinators of many less specialized genera as well: Agastache, Arbutus, Arctostaphylos, Cirsium, Dicentra, Dudleya, Eriodictyon, Erysimum, and Xylococcus. In all communities hummingbird pollination is confined to only several (usually less than 10) plant species, which typically exhibit protracted anthesis periods. Too much emphasis has been placed on the difference in pollination by sphinx moths and hummingbirds; both are high-energy-requiring facultative homeotherms and both tend to visit the same species of plants (often contemporaneously). A critical paper by Watt et al. (1974) demonstrated conclusively that the floral adaptation to both pollinators was similar. Plants supporting these pollinators usually produce voluminous nectar of complex rather than monomeric sugars; these nectars, therefore, contain increased energy at the concentrations characteristic of most other plants. Evolutionarily the increased specificity and distance of pollen transport has evidently been worth the added energetic cost to the plant. Important studies on hummingbird pollination in California have included those of Pearson (1954), Grant and Grant (1968), Hainsworth et al. (1972) and Stiles (1973).

SUMMARY

Synecological analyses of pollination ecology have been initiated only recently. Nevertheless, studies have shown conclusively that in some vegetation types (e.g., alpine tundra, subalpine marsh-meadow, subalpine forest, northern coastal shrub, coastal sage, maritimal dunes, redwood forest, and mixed evergreen forest) most plant species are pollinator limited and must compete for visitation by vectors which are generalist feeders and must be supplied with a sufficient reward to ensure subsequent visits to the same plant species. In chaparral, valley grassland, warm desert, weed, and open forest communities, pollinators are usually very abundant and

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[e] Aconitum, Agave, Antirrhinum, Aquilegia, Astragalus(?) (Grant and Grant 1968), Beloperone, Brodiaea, Castilleja, Chamaenerion, Chilopsis, Cleome, Cleomella, Collomia (?) (Garnt and Grant 1968), Delphinium, Fouquieria, Fritillaria (?)(Grant and Grant 1968), Galvesia, Gilia (Ipomopsis), Iris, Isomeris, Lepechinia, Lilium, Lobelia, Lonicera, Lycium, Mimulus, Mirabilis, Monardella, Pedicularis, Penstemon, Ribes, Ruellia, Salazaria, Salvia, Scutellaria, Silene, Teucrium, Trichostema, Zauschneria.

flower visitation is assured; specialist pollinators are abundant in these environments. However, those perennial plants that require outcrossing still must rely upon large-bodied, far-ranging generalist pollinators to achieve efficient interplant pollen flow.

Though many of the interrelations between plants and their pollinators have now been tentatively delineated, we know little of the ecological and evolutionary significance of different modes of pollination. Unquestionably, valid representations can be made of community-wide phenomena as as they occur in various localities throughout the state. It must be remembered, however, that the pollination of any one particular plant species is subject to considerable variability depending upon circumstance. Since the energetic and nutritive reward of the floral attractants is genetically determined and not subject to modification by the immediate competitive environment of a plant individual, competition patterns for vectors may have considerably different outcomes locally; some cornucopia species may be barren of vectors and some habitually selfed species may be heavily outcrossed. Knowledge of the patterns of pollination interactions within differing vegetation types now permits us to assess the roles of these pollination syndromes in the evolution of our native plant communities.

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APPENDIX

POLLINATORS AND BREEDING SYSTEMS OF THE ENTOMOPHILOUS AND ORNITHOPHILOUS PLANTS OF CALIFORNIA

Three hundred genera of the California flora are cited below associated with their documented major pollinators. Where known, an estimate is made of the effectiveness of their outcrossing and whether or not selfing is possible as well. Anemophilous genera, habitually selfed genera, and genera about which I have no first-hand knowledge are omitted. Genera are presented alphabetically and the number which precedes them is cited in the previous figures.

The first column represents the results of bagging and greenhouse transplantation studies. G=genetically self-compatible; I=self-incompatible; A=apomictic. If genetically self-compatible, the number which follows is my rough estimate of the degree of outcrossing usually encountered in native populations of species of this genus. (1=habitually selfed; 5=nearly always very heavily outcrossed.) If self-incompatible, the number represents the usual level of seed-set encountered in wild populations and the general abundance of pollinators observed on the flowers. (1=seldom visited, seed-set very low; 5=heavy visitation and full seed-set). "I" indicates strong mechanical or temporal barriers to inbreeding even though the flowers are genetically self-compatible to my knowledge.

The second column indicates the major pollinators (not simply visitors) of the genus. Especially important groups are denoted by "!". BBY=Bombyliidae, B=Bombylius,

O=tiny species such as Oligodranes and Phthiria, V=short-tongued groups such as many Villa, A=the closely related Acroceridae; MUSC=Muscoidea; PFLY=primitive Diptera such as gnats and mosquitos; SYR=Syrphidae; TACH=Tachinidae; TEPH=Tephritidae; WASP=Sphecidae and Vespidae; MASAR=Pseudomasaris (Masaridae); PWSP= Ichneumonoidea; SAWF=sawflies (Tenthredinidae); BEET= beetles (Coleoptera), BP=Buprestidae, CC=Coccinellidae, CH=Chrysomelidae, CY=Cerambycidae, D=Dermestidae, MD= Mordellidae, ME=Melyridae, ML=Meloidae, EL=Elateridae, NT=Nitidulidae; BUTT=butterfly; MOTH=non-sphyngid moth.

The third column represents the known important bee pollinators of the respective genus (occasional visitors are not cited, only those frequent and widespread enough to act as significant factors in the pollination ecology of the genus). Collective designations are employed where possible: CMP=the guild of Compositae-specific bees of diverse families; HAL= the guild of "table-scrapping", sometimes colonial, Halictinae which are generalist feeders usually; PLY= an even more inclusive category of generalist feeding bees, including many genera in all families and many species of bees whose males may be common generalists even though the females are restricted to one genus of plants.

UNDERLINING signifies that the cited genus contains one or more species restricted to, or heavily emphasizing, pollen-collection from this plant genus throughout large geographic areas. AG=Agapostemon, AD=Andrena, ANT=Anthidium, AN=Anthophora, AS=Ashmeadiella, AT= Anthocopa, AU=Augochlorella, BB=Bombus, CH=Chelostomoides, CL=Chelostoma, CN=Centris, CO=Conanthalictus, CR=Ceratina, CT=Colletes, DD=Diadasia, DI=Dialictus, DN=Dianthidium, DF=Dufourea, EM=Emphoropsis, EV=Evylaeus, EX=Exomalopsis, HM=Hypomacrotera, HP=Hoplitis, HS=Hesperapis, HY=Hylaeus, HT=Heteranthidium, ID=Idiomelissodes, LS=Lasioglossum, LT=Lithurge, MG=Megachile, ML=Melissodes, ND=Nomadopsis, NM=Nomada, NO=Nomia, OS=Osmia, PN=Panurginus, PP=Peponapis, PR=Perdita, PRT=Proteriades, PT=Protodufourea, SP=Sphecodes, SY=Synhalonia, TP=Triepeolus, XG=Xenoglossodes, XN= Xenoglossa, XR=Xeralictus, XY=Xylocopa, θ signifies groups conspicuous in their absence, as we presently understand the occurrence of pollinators.

1	*Abronia*	?I/G-1	SPHINX	AN,BB
3	*Acacia*	I-4	WASPS!	PR,CT,CH
6	*Acamptopappus*	?G	BBY	CMP!PLY(DI)
8	*Acer*	I-5/G-2	wind,PWSP	BB!
9	*Achillea*	I-3	BEET!(CY,D,MD, CC)SYR!MUSC!WASP!	PLY(HY!LS!EV,SP) Θ(CMP,BB)
14	*Aconitum*	G,A-5	BIRD!	BB!
17	*Adenostoma*	I-3	BEET!(CC,D),WASP, BUGS,MOTHS	HAL!(AG,AU),PR, HS
19	*Aesculus*	G-5	BUTT!SPHINX!MOTH	EV
20	*Agastache*	?-5	BIRD	BB!XY!AN!
21	*Agave*	I-5	BIRD!	PR,XY
22	*Agoseris*	I-?	BEET(BP),SYR	AD!AD!PR!HAL! Θ(CMP)
28	*Allium*	G-3	BBY(B),BIRD	BB!CH,OS,HP, DI,NM
29	*Allophyllum*	G-2	BBY(O)	---
36	*Amelanchier*	I-2	SYR	AD!
40	*Amorpha*	?-5	BUTT!	CT!PLY
42	*Amsinckia*	G/I-1/5	BBY!(B,O),BUTT	AN!OS!SY!BB! EM!ML
45	*Anaphalis*	?"I"	BEET(MD!)	PLY,Θ(CMP)
50	*Angelica*	?	BEET(MD!)	PLY(HY,DI)
51	*Anisocoma*	?	BBY	AN!ND!PLY(DI,AG) Θ(CMP)
52	*Antennaria*	?"I",A-1	PWSP,BUTT,MUSC, WSP!	Θ(CMP)
53	*Antirrhinum*	G-1/5	BIRD!	PLY
56	*Apocynum*	?	WASP!BUTT!	PLY(HY!DI)
57	*Aquilegia*	G-5	BIRD!SPHINX!	BB!
58	*Arabis*	G-1	SYR	PLY
60	*Arbutus*	I-2/5	BBY(B),BIRD	BB!EM!OS!
61	*Arceuthobium*	I-?	GNATS	---
63	*Arctostaphylos*	I-5	BBY(B,O),MUSC, BIRD	BB!AD!AD!EM!SY! OS!HAL,NM
64	*Arenaria*	G-2	WASP,SYR	HAL,AD
65	*Argemone*	?	BEET(ML)	HAL!PR,AD
66	*Aristolochia*	I-?	MYCETOPHILIDS	---
68	*Arnica*	G,I,A-1	BUTT	BB,Θ(CMP)
71	*Asarum*	?	MYCETOPHILIDS	---
72	*Asclepias*	I-5	BUTT,WASP,BEET(MD)	PLY(HY,DI),XY!BB, MG,ML
73	*Aster*	(G)I-1/5	BUTT,MUSC,BBY(V,B)	CMP!HAL!
74	*Astragalus*	I,G-1/5	BUTT,BIRD?	AT!ANT!OS!SY!BB! HP!

79	Baccharis	I-1/5	BEET!(MD),WASP! MUSC!PWSP	DI!HY!PR,BB!Θ(CMP)
82	Baileya	?	BBY(V)	CMP!(PR,ML),PLY!
83	Balsamorhiza	?I-5	BUTT	CMP!BB
84	Barbarea	±I-3	BUTT!	AD,PLY
86	Bebbia	?	MUSC!BBY(V,O)	CMP!Θ(HAL)
87	Beloperone	?I	BIRD!	AN
89	Berberis	I-1/5	---	BB!AD
95	Blennosperma	G-?	---	AD!AD
99	Boerhaavia	?	MUSC,TIPHIIDS	EXO,HAL
100	Boisduvallia	G-2	BBY(V)	---
108	Brodiaea	I-3/5	BEET(CY,ME,D),SYR BBY(A,B),BIRD?	BB!SY!HAL!OS!
112	Calandrinia	G-3	---	AD,HAL
113	Calliandra	I-1	---	DI
114	Calochortus	G-5	BEET(CY,ME,MD,D, BP),+++	PR!ND!DF!++
118	Calycadenia	?	BBY(O,V),PWSP, BEET(ME,ML),++	CMP!HAL!
119	Calyptridium	G-1/5	BUTT,WASP,BEET(ML)	PLY
120	Calycoseris	?G	BBY!(O),BEET(ML)	ND,PR,PLY
122	Calystegia	?	BBY(A)	DD!CR,PLY(HAL)
124	Camissonia	G/I-1/4	---	AD!DF!HAL,PLY,+
131	Cassiope	I-5	---	BB!AD
132	Castilleja	I/G-2/5	BIRD!	BB!AN,OS
135	Ceanothus	I-5	PFLY,MUSC,SYR, BBY(O),BEET(CY! D,ME,CC,EL)	AD!AD!PN!HAL! BB!HY
137	Centaurium	G-2/3	BBY(B)	HAL,CR
141	Cercidium	I-5	---	CN!AS,CH,CT,PR
142	Cercis	I-5	---	XYL!BB
143	Cercocarpus	G-3	---	BB,AN.EM,DI,EV
145	Chaenactis	G-1	BEET(ME!),BBY! (O,B,V)	CMP!HS,Θ(BB)
147	Chaetopappa	?G-4	BBY(V!),BUTT	AS,DS,PLY Θ(BB,MG,ML)
148	Chamaebatia	?-2/5	BUTT!WASP,BBY(V) BEET(D,MD)	AD!ND!HAL!OS! HP,PLY
151	Chamaenerion	"I"-5	BIRD,SPHINX	BB!PLY
153	Chilopsis	?I-5	BIRD	PLY!XY!CN!AN,MG
155	Chlorogalum	G-5	SPHINX,MOTH,WASP	BB!HAL
156	Chorizanthe	G-1	WASP,BBY(O)	PLY
158	Chrysopsis	I-4	BUTT!	CMP!BB!HAL!
160	Chrysothamnus	I-5	BUTT!WASP!+++	CMP!(AD!CT!MG! ML!PR!),PLY!BB!++

163	Cirsium	I-5	BIRD!BUTT!BBET (ME)	OS!CMP!(OS,MG, DN),BB!HAL!SY!PL
164	Clarkia	G-2/5	BIRD?MOTH,BEET (M,BP,CY),BBY (B,O,V,A)	HS!MG!AD!OS,HAL (EV,DI),CR++
166	Clematis	G/I-1	SYR,BBY	BB,AD,NM,PLY
167	Cleome	?	BUTT!BIRD!	BB,PLY,ND
168	Cleomella	?	BIRD?BUTT	BB!HAL!PLY,PR,ND
171	Coldenia	?G-2	---	PR!
173	Collinsia	G-2/5	---	OS!HP!AT!Θ(BB,HA
174	Collomia	?G-1/5	BBY(B),MOTH,BIRD?	---
184	Cordylanthus	?-4	WASP,BBY(O,V)	CH!ANT!AS,MG
185	Coreopsis	?-5	SYR,BUTT?	CMP!OS!HAL,AD, SY,TP
186	Corethrogyne	?I-5	BUTT,BBY(V)	CMP!(ΘMG,ML),HAL PLY
187	Cornus	?-1	BEET(CY)	---
190	Cowania	?	BEET(MD,D)	PR,PR,PLY,HAL,AD
192	Crepis	I,G,A-?	SYR,BEET(BP!), BUTT	AD!HAL!
196	Croton	?	WASPS!	HAL!PR,MG,ML,PLY
197	Cryptantha	G-1/3	BBY(B,O,A)! WASP!TACH	AD,PRT + all groups
198	Cucurbita	I-5	---	PP!XN!AG
199	Cuscuta	G-1/3	WASP!	PLY
202	Cymopterus	?	BBY,WASP,SYR	DI!
204	Cynoglossum	I-3/4	BBY!(B)	AN!
206	Dalea	G/I-1/5	WASP	AT!ANT!AS!PR!OS! PR,PLY
209	Datura	?	SPHINX	HAL!PLY
211	Delphinium	G-4/5	BIRD!	BB!SY
212	Dendromecon	?-2	SYR	PLY
213	Dentaria	I-2	BBY!(B),SYR	AD!
214	Descurainia	G-3	SYR	AD,HAL
215	Dicentra	?	BIRD	CH!XY!OS
223	Dodecatheon	G-2	---	BB
225	Draba	G-1	SYR	HAL
228	Dudleya	G-5	BIRD	BB!AN!
233	Echinocactus	?	---	DD!AS,LT!DI
234	Echinocereus	?	BEET(NT),BIRD?	DD!AS,LT!PLY
238	Emmenanthe	G-2	BBY(B)	HAL,PT,CO
240	Encelia	I-2/5	BUTT,TEPH,SYR, BBY(V),BEET(ML, CC),WASP	CMP!AN,HAL!AD! PR ++
242	Epilobium	G-1/3	SYR	HAL,PLY

244	Eremocarpus	?G	wind?+BUTT,WASP, BBY,TACH	HL!DI!PLY
245	Eriastrum	G-1/3	BBY(B,O)	PR,DN,HAL
246	Erigeron	I,G,A-?	BUTT!BBY(V)++	CMP!(OML),DN! PR!HAL!HY!
247	Eriodictyon	?-5	BUTT!BIRD!MASAR WASP	BB!ND!CL!AN!OS! HY
248	Eriogonum	G/I-1/5	WASP!BUTT,MUSC, BEET(MD,CR)BBY(O, V,B,A)	BB!PR!CT!HAL! HY!PRO!
249	Eriophyllum	G/I-3/5	BUTT!SYR,BEET (BP,CY),WASP	BB!HAL!AD!OS!
251	Eryngium	G-1/2	SYR,WASP,BBY,BUTT	HY!HAL!
252	Erysimum	?I-2/4	BIRD,SYR,BUTT	HAL!AD,PLY
254	Eschscholzia	G/I-1/2	BEET(ML,ME)	BB!DF,HAL!PR!
255	Eucnide	?	---	HS!PR!DI,PR!
257	Euonymus	I-1	---	DI,BB?
259	Euphorbia	?-1/3	WASP +	ND!PR!DI
270	Fouquieria	?-5	BIRD!	---
271	Fragaria	G-3	SYR,BBY(B),BEET (BP)	AD!NM,OS
272	Frankenia	G-1	---	DI,PLY
273	Frasera	?	WASP	BB!PLY
275	Fremontia	?	---	XY!PLY
276	Fritillaria	?	BIRD?	AD
281	Gaura	?	MOTH	---
282	Gayophytum	G-1/3	BBY!(B,V),SYR	AD,DF!PLY
283	Gentiana	G/I-3/5	---	BB!
284	Geraea	?	?	CMP!HAL!PR,HS
285	Geranium	G-1/3	SYR,BEET,WASP	BB!HAL!HY
286	Geum	G-1	MUSC	AD
287	Gilia	G-4	BBY!(B,O),BUTT!	DF!HAL!HP!OS! PLY
290	Glandularia	"I"-5	BUTT!	---
293	Glycyrrhiza	G-3	---	BB!OS!AN
295	Gnaphalium	?	BEET(MR),WASP!	HY!CT,DI
299	Grindelia	?-5	BUTT,BBY(V),BEET (ML)	CMP!BB!HAL!PLY
300	Gutierrezia	?-5	BBY(V),BUTT,WASP	CMP!CT!PR!HAL! PLY ++
302	Habenaria	G-1	MOSQ	---
303	Hackelia	G-3/5	SYR!BUTT,BBY(B)	OS,PLY
305	Haplopappus	I-5	BUTT!WASP!BBY(V)	CMP!BB!HAL!PR, PLY ++
309	Helenium	?	BUTT	CMP!BB!HAL!
310	Helianthella	I-5	BEET(BP,CY),BUTT TEPH	OS!SY,PLY

311	Helianthemum	G-1	---	HAL
312	Helianthus	I-5	BUTT!WASP! +	CMP!BB!HAL!PLY++
313	Heliotropium	G-1/3	BBY	AN!AS,HAL,ND,PR
315	Hemizonia	?-5	BBY(V),SYR,BUTT, BEET(ML)	AD,ML!XG!HAL!TP
316	Heracleum	?	SYR!MUSC	HAL,BB!
318	Hesperocallis	I-5	SPHINX	---
319	Hesperochiron	?G-3	---	OS,HP,CH,PLY,BB
326	Heteromeles	I-2	BEET(MD,D),WASP, SYR,BUTT	HY,HAL,PR,AD
327	Heterotheca	?-4	BEET(MD),BUTT	CMP!HAL!PR
328	Heuchera	?	PFLY!BBY(O),SYR	---
332	Hoffmannseggia	I-5	---	CN,BB,AN
337	Holodiscus	I-2	PFLY, BEET(MD,D)	HAL,HY,AD
339	Horkelia	G-1/3	BUTT!BBY,BEET(D)	PLY(HAL,HY,OS,AD) ND!
344	Hydrophyllum	?G-3	---	BB!
351	Hyptis	?I-5	BUTT,SYR,BBY(V), BIRD	PLY(OS,PR,HAL,AD)
354	Ipomopsis	G?-5	BIRD!	---
355	Iris	"I"-3/5	BIRD!BBY(A)	BB!OS!
356	Isomeris	I-5	BIRD	BB!HAL,SY,AN
365	Kalmia	I-4	---	BB!AD!OS!
366	Kelloggia	?G-2	BBY(O)!	PLY
369	Krameria	?	---	CN!
374	Larrea	"G"-5	+++	XY!CT!PR!HT!PLY +
375	Lasthenia	G/I-1/5	BBY(V)!BUTT!	AD!HAL!NM,AD +
376	Lathyrus	I-5	BUTT	BB!SY!OS!PLY
378	Layia	G/I-1/5	BUTT!BBY(V),SYR	AD!AD!HAL!
379	Ledum	I-1	BEET(MD),SAWF	BB!OS
383	Lepechinia	?-5	BIRD!BBY(A)	BB!OS!CH,AS
384	Lepidium	G-1/2	MUSC	PR!AD!HAL!
385	Lepidospartum	I-5	BUTT,WASP!	HAL!XY!PR,CMP! Θ(ML,MG)
386	Leptodactylon	I?-1	MOTH	---
387	Lesquerella	G-2	SYR!	AD
388	Lessingia	?I-5	BUTT!BBY!(V),SYR	CMP!(ΘMG),HAL
393	Ligusticum	G-3	MUSC,PWSP, BEET (MD)	HAL
396	Lilium	I-?	BIRD!SPHINX!	BB!
397	Limnanthes	G-4	BUTT	AD!PN!OS,PLY
400	Linanthus	G-3/5	BBY!(B,A),BUTT,SYR	AD,DF,PLY
401	Linum	G-1/4	BUTT	BB,PLY
406	Lithocarpus	"I"-5	wind +	CT!
407	Lithophragma	I,A-2	BBY(B)	AD,BB
409	Lobelia	?	BIRD	---

411	Lomatium	"G"-5	TACH,SYR,BEET,(MD),BUTT	AD!AD!HAL!
412	Lonicera	?	BIRD!	BB!EV,XY!
413	Lotus	I/G-1/5	BUTT	BB!OS!SY!ANT!
417	Lupinus	I/G-1/5	BUTT	BB!OS!SY!ANT!AN!EM!XY
418	Lycium	?	BIRD	AN,AN,HAL,ID
426	Machaeranthera	I-?	BUTT +	CMP!HAL!PR
428	Madia	G-2/5	BEET(BP),MOTH	HAL!CR,BB!
430	Malacothamnus	?-5	BEET(MD)	DD!HAL!PLY
431	Malacothrix	?-3/5	BBY!(O,V)	ND!AD!PR!HAL!PLY!DF!
435	Malvastrum	G-1	---	DD!
437	Marah	I-1	?GNATS	AD,BB
440	Meconella	?	---	AD,HAL!
442	Mentha	?	BUTT	BB!HAL!
443	Mentzelia	G-1/5	MOTH?	PR!BB!HAL!PLY,XR,PRT
446	Mertensia	G?-5	---	CT!BB,OS
447	Mesembryanthemum	?-5	WASP	BB!HAL!PLY
450	Microseris	G-2	BEET(BP!),SYR	AD,BB,HAL
451	Microsteris	G-1	BBY(B!)	---
452	Mimulus	G/I-1/5	BIRD!BBY(A)	OS!HP!DF!BB!MG
453	Mirabilis	?G-2	BIRD!SPHINX	HAL,PLY,AN
455	Mohavea	G-2	---	XR,PR
457	Monardella	?-5	BBY!(B,O,A),BUTT! BIRD!	BB!OS!DN,AS,AN,HY,ND
463	Montia	G-2	BBY(B),SYR	AD,NM
471	Nama	G-2/4	---	CO,ND,AS,AT
473	Navarretia	G-2	BBY(B)	PR,EX,PLY(ΘHAL)
476	Nemophila	G/I-1/5	SAWF!SYR	AD!AD!DF,PN!OS!AT,CL,NM
478	Nicotiana	G-3	SPHINX,BIRD	---
484	Oenanthe	G-3	MUSC,BEET(MD),SYR	HAL
485	Oenothera	I-5	SPHINX!	AD,HAL
486	Olneya	I-5	---	CN!CH!AS!
487	Opuntia	A,?-1/5	?	DD!AS,LT!HAL!
492	Orthocarpus	G/I-1/5	SYR,MOTH	BB!AD!HAL
494	Osmaronia	I-1	MUSC	AD
496	Oxalis	I.A-?	PFLY,BBY(B)	BB
504	Paeonia	G-2	---	AD,HAL

505 Palafoxia	?G-2	BUTT +	CMP!HAL!
509 Parkinsonia	I-5	---	BB,XY,CN
513 Pectis	G-3	BBY! +	CMP!PR!HAL,NO
515 Pedicularis	?-5	BIRD!BUTT	AN!BB
517 Penstemon	"I"-5	BIRD!MASAR!BBY (A)	OS!OS!AT!HP!BB! PLY +
521 Perideridia	G-4	WASP!BEET(MD), SYR,MUSC	HYL!PLY
523 Petalonyx	G-?	BBY(V,B,O),WASP	AS,PR,HAL
529 Peucephyllum	G?-2	---	PLY(ΘCMP)
530 Phacelia	G-5	MASAR!BUTT!BBY! SAWF!	ANT!AT!CH!CT!CO! AD!DF!HP!HS,BB! CL!HAL!OS!SY!XY
531 Phalacroseris	?	?	OS!PLY
532 Philadelphus	?-3	BEET(CY)	AD
533 Phlox	I-1	BUTT!MOTH!	---
536 Pholistoma	G-5	TENTH	AD!PLY
537 Phoradendron	I-1	PFLY	AD
539 Phyllodoce	?-5	SYR	BB!AD,OS,HAL,PLY
541 Physalis	?	---	PR,HM,CT,PLY
548 Plagiobothrys	G-2	BBY!(B,O),SYR	AD,HAL
551 Platystemon	I-3	SYR	AD!AD,HAL
552 Plectritis	?	BBY(B),SYR	OS,NM,HAL,PLY
554 Pluchea	?	?	MG,ML,AN,HAL,AS
558 Polemonium	G-2	---	BB!
569 Potentilla	G-1/5	MUSC!BBY!MOTH!	AD!ND!HAL,NM,HY, DF
571 Proboscidea	?	---	BB,PR,CN,AN
572 Prosopis	I-5	WASP!	CN!AS!CH!HAL!HY, PR +
574 Prunus	I-4	SYR,BEET(CY,D)	AD!HAL,HY,BB!NM
575 Psathyrotes	?	BBY!(V),TACH!	Θ(CMP)
580 Psoralea	?	?	CN!OS,BB!SY,AN
586 Purshia	?	---	BB!EM!AD!
590 Rafinesquia	?G-?	BBY(O)	AN,HS,NO
591 Raillardella	I-1/5	BEET(ME)	BB!OS!
592 Ranunculus	G-1/5	SAWF!PFLY!MUSC! BUTT!BEET(CY,BP) SYR	AD!AD!PN!HAL!
593 Rhamnus	I-5	WASP!SYR,BEET (CY)	AD!BB!HAL!HY! PR,PN
594 Rhododendron	I-5	BIRD,SPHINX! BBY(A)	BB!
595 Rhus	I-2/4	BEET(CY)	AD,BB,NM,HY,PR
596 Ribes	I-5	BIRD!	BB!AN!EM!OS!AD!

601	*Rosa*	G-4	BEET(BP,CY,D)	BB!CR,PLY
603	*Rubus*	A/G-2/5	BEET(CY,D)	BB!AD!HAL!OS!
609	*Salazaria*	?	BIRD	AN!HAL!
611	*Salix*	I-5	SAWF!WASP,SYR, BUTT	AD!AD!BB!HAL!NM, HY,PR
612	*Salvia*	?-5	BBY(B,A)!BIRD!	AN!AN!EM!OS!HAL! SY!
613	*Sambucus*	G-2	BEET(CY,MD!), WASP,PFLY,SAWF!	AD,CR
615	*Sanicula*	G/I-1/3	SYR!TACH!MOTH	AD!AD!HAL
620	*Satureja*	?	BIRD	BB!OS!PLY
621	*Saxifraga*	I/G/A-1/2	SYR	PLY
624	*Scoliopus*	I-1	MUSC	---
626	*Scrophularia*	I-5	BIRD!WASP!	BB!HAL!CR!HY,AD
627	*Scutellaria*	?	BIRD!	BB!OS!
628	*Sedum*	G-1/3	MUSC!	BB!OS!HAL!
629	*Senecio*	G/I-1/5	BUTT!SYR,BEET (BP),MUSC	CMP!BB!OS!PLY ++
636	*Sidalcea*	?-5	BEET(CY)	DD!SY,BB,HAL
637	*Silene*	G/I-1/2	MOTH,BIRD	---
639	*Sisyrinchium*	I/G-2/3	SYR!	HAL!
642	*Smilacina*	I-2	SYR!BBY(B)	AD!NM!
644	*Solanum*	G/?-1/4	BBY(B)	AN!BB!HAL!XY
645	*Solidago*	I-5	BUTT!WASP!TACH BBY(V,O),BEET(ME)	CMP!BB!HAL!HY,XY!+
649	*Spergularia*	G-1	SYR	HAL
650	*Sphaeralcea*	?-5	---	DD!CT!HAL!PLY
651	*Sphenosciadium*	G-5	WASP!MUSC!BEET (MD)	HY,HAL!BB!PLY
652	*Spiraea*	?-4	SYR	AD,BB
655	*Stachys*	?-5	BIRD?	BB!AN!XY,PLY
656	*Stanleya*	I-5	BUTT!	ND!BB!HAL!PLY
661	*Stephanomeria*	?-3	BUTT!BBY!(V)	CMP!AN!BB,HAL! TR,CR
662	*Stillingia*	?	WIND + WASPS	---
664	*Streptanthus*	?	BUTT,SYR	BB,AN,OS
672	*Swertia*	?	WASP!BEET(MD,D)	HY!HAL!PLY
674	*Symphoricarpos*	?-2	WASP,SPHINX	BB,HAL,PLY,DF
678	*Taraxacum*	A/?-2	SYR!	HAL!AD,OS
683	*Teucrium*	?	BIRD?	HAL
686	*Thelypodium*	?	---	ND,PR
687	*Thermopsis*	?	---	BB!OS,SY,XY

689	Thysanocarpus	G-2	SYR	AD
691	Tidestromia	G?-2	WASP, BBY	AS, EX, PR, ND
693	Tofieldia	?-3	BEET(CY!)	AD!
704	Trichostema	?-5	BIRD!WASP, BBY (B,O)	AN!AS!HAL!HY, MG, ML, SY, XY
705	Trientalis	I-2	SYR	HAL
706	Trifolium	G/I-1/5	BBY(B), BUTT	BB!KD!ANT!MG, OS! SY!DF
714	Umbellularia	I-1	BBY(B), TACH	BB!
717	Vaccinium	I-3	---	BB!OS
718	Valeriana	?-3	SAWF!SYR	PLY
721	Veratrum	?-1	WASP, MUSC, PWSP	BB
722	Verbena	"I"-5	BUTT!BBY(V)	PLY(BB, CR, MG, ML, OS)Θ(HAL)
726	Vicia	I-5	BUTT!	OS!SY!BB!ΘHAL
727	Viguieria	I-5	BUTT!WASP!BBY (V)	CMP!HAL, Θ(ML)
728	Viola	G/I-1/3	BBY!(B)	PLY(BB, OS, DI, AS)
730	Whipplea	?-2	BBY(B)	HAL
732	Wislizenia	?G-3	BUTT, WASP	PLY(HAL!BB, MG, ML, XY)
735	Wyethia	I-5	BUTT, SYR, BBY (B,A), BEET(CY!BP!)	OS!BB!MG!AD, HAL
739	Yucca	I-3	MOTH	---
741	Zauschneria	"I"-5	BIRD	---
742	Zigadenus	G-3	SYR	AD!

N.B. Results in this table represent general trends and are based on observations of a mere 2500 species plus the results of the bee catalogue. They are not meant to be taken as descriptive of yet unstudied species, though they may serve as bases for predictions.

A New Peperomia (Piperaceae) from Maui

Hawaiian Plant Studies 48

Harold St. John
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Peperomia *waihoiana* sp. nov. (subgen. *Sphaerocarpidium*, sect. *Verticillatae*).

Fig.

Diagnosis Holotypi: Plantae parvae molles sunt, caulibus simplicibus vel ex basi pauce ramosis saliente albi-hirtellis pilis 0.3-0.4 mm longis, internodis superis 1-5 mm longis illis inferis 7-12 mm longis, foliis oppositis ex 1-2 nodis superis, petiolis 3-13 mm longis saliente albi-hirtellis, laminis 10-22 mm longis 7-14 mm latis ellipticis in sicco crasse chartaceis supra obscure viridibus glabris infra pallide viridibus omnino sparse hirtellis et in midnervo densiore nervis supra sub oculos non caditis sed infra paene evidentis palmatim trinervosis et midnervo in medio cum 2 nervulis lateralibus, spica terminali solitaria 15-25 mm longa, pedunculo 5-7 mm longo sparse hirtello plerumque ad basim, rhachidi glabro, bracteis 0.2-0.3 mm diametro subrotundatis peltatis, filamenta 0.3 mm longa, anthera 0.1 mm longa dimidiata, ovario lancei-obovoideo rostrato, stigmatibus 2 apicalibus aequalibus binis, fructibus 0.4 mm longis subglobosis glandulose verrucosis apice subobliquo.

Diagnosis of Holotype: Small, delicate plants; stems 20-25 mm tall, when dried 0.5-0.7 mm in diameter, simple or few branched from the base, white spreading hirtellous, the hairs 0.3-0.4 mm long; upper internodes 1-5 mm long; lower internodes 7-12 mm long; leaves opposite, borne at the 1-2 upper nodes; petioles 3-13 mm long, similarly white spreading hirtellous; blades 10-22 mm long, 7-14 mm wide, elliptic, thick chartaceous when dried, above dark green, glabrous, below pale green, sparsely hirtellous throughout, and more densely so on the midrib, the veins invisible above, but faintly visible below,

palmately trinerved and the midrib with a lateral branch on each side at about the middle; spike terminal, single, 15-25 mm long; peduncle 5-7 mm long, sparsely hirtellous, mostly below; rhachis glabrous; bracts 0.2-0.3 mm in diameter, roundish, peltate; filament 0.3 mm long; anther 0.1 mm long, dimidiate; ovary lance-obovoid, beaked; stigmas 2, apical, equal, paired; fruit 0.4 mm long, subglobose, glandular verrucose, the apex slightly oblique.

Holotypus: Hawaiian Islands, Maui Island, Haleakala, Waihoi Valley, North Waiohonu Trail, 2,400-2,650 ft. alt.,under shaded but fairly dry ledges, July-Aug. 1972, Betsy Harrison 197 (BISH).

Discussion: Of this new species the closest relative is P. Cookiana C.DC., var. minutilimba Yuncker, a variety with the stems about 4 cm tall, appressed hirtellous; leaves opposite or whorled; petioles to 3 mm long; blades to 9 mm long and 8 mm wide, ovate to orbicular, hirtellous above, near the base spirally minutely puberulous below; spikes 15 mm long; peduncle 3-4 mm long; fruit 0.75 mm long, subrostrate, oblique, and the stigma subapical. P. waihoiana has the stems 2-2.5 cm tall; leaves opposite; petioles 3-13 mm long; blades 10-22 mm long, 7-14 mm wide, elliptic, glabrous above, hirtellous below; spikes 15-25 mm long; peduncle 5-7 mm long; fruit 0.4 mm long, subglobose, the apex slightly oblique, but the stigmas apical.

The new epithet is formed from the name of the type locality, Waihoi, and -ana, the Latin adjectival suffix, meaning connected with.

Legend

Fig. 1. Peperomia waihoiana St. John, from the holotype. a, habit, X1; b, stem, node, leaf, X 4; c, bract, X 25; d, drupe, X 25.

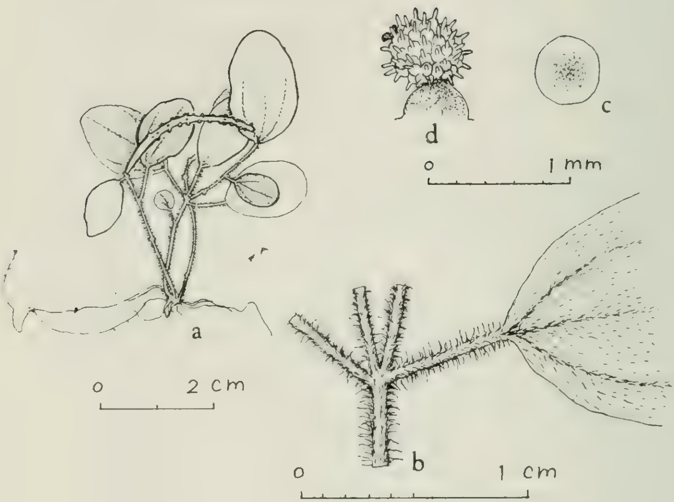

Figure 1

POLIANTHES HOWARDII (AGAVACEAE):

A NEW SPECIES FROM COLIMA

Susan Verhoek
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Within the Mexican genus Polianthes L. the group of species which has been treated as section Bravoa (Lex.) Pax & K. Hoffm. includes those species with tubular, usually pendent, red or orange flowers with filaments inserted in the basal half of the tube. In most of these species the flowers are without green or brown coloring, are paired at the nodes, and the mouth of the flower is essentially symmetrical. A species different from the majority in all three of these characters has been collected in Colima and is described for the first time here.

Polianthes howardii Verhoek, sp. nov. (Fig. 1a,b).
Inflorescentia laxa, 73.0-111.0 cm alta; flores ad nodos singulatim portati, longe pedicellati, patenti-pendentes, corallini sed gradatim in tertia parte suprema viridescentes, interius saepe marrino-vittati, tubo fere recto, postice (superne) quam antice longiore, ore asymmetrico, staminibus ad basem tubi affixis.

Rhizome fleshy, erect, 3.0 cm long, 0.9 cm in diameter, surmounted by a rosette of leaves, base of rosette surrounded by remnant leaf bases 3.5-4.0 cm long; roots fleshy near rhizome, becoming wiry distally. Leaves 5-6, erect-spreading, broadly channelled, narrowly oblanceolate to linear with acute or mucronate apex, 22.0-27.0(-36.0) cm long, (1.1-)1.5-2.5 cm broad, grass-green, glabrous, glossy, sometimes flecked with magenta toward base underneath; margin entire. Inflorescence 73.0-111.0 cm tall, glabrous, sometimes flecked with magenta at base; flowering part elongate, open, 21.5-70.5 cm long, with 13-30 floral nodes, lower internodes ca. 3.0-5.0(-10.0) cm long; bracts of scape ca. 7, gradually smaller than the leaves; floral bracts lanceolate, acuminate, abruptly smaller than the sterile bracts, 1.5 cm long or less; bracteoles single, small. Flowers solitary at the nodes, long-pedicellate, tubular, glaucous, exterior coral-red at base, grading to green in upper third, irregularly streaked with yellow, interior greenish-yellow, often with maroon stripes that extend approximately halfway into the tube; pedicels erect, 1.7-2.9(-5.3) cm long, slender in flower, becoming thicker in fruit; mature flowers semipendent, hanging at an approximately 30° angle from horizontal; ovary 0.3-0.4 cm long, 0.25-0.3 cm in diameter; tube constricted just above the ovary, inserted at a slight angle to the ovary, nearly straight, top of tube over-reaching bottom by 0.1-0.2 cm so that the mouth is asymmetrical,

Figure 1. Polianthes howardii, a. middle section of inflorescence (X 0.75); b. flower with anthers (arrow) positioned at top of floral tube (X 1.5).

top of tube 1.8-2.1 cm long, 0.3-0.5 cm in diameter; segments short, slightly flared, rounded, 0.15-0.3 cm long, 0.2 cm wide, apical hair tuft slight; stamens included, filaments as long as the tube, attached near base of tube, the upper slightly longer than the lower; anthers yellow, attached medially, ca. 0.5 cm long, not freely moving; style white, at maturity longer than the stamens, exserted by ca. 0.2 cm; stigma white, papillate, 3-lobed, the lobes reflexed at maturity. Fruit a globose capsule, 0.8-1.0 cm in diameter.

Type: MEXICO. COLIMA: 3 1/2 mi S of Tequizatlan at K 211 on Mex. 110 at a microondas (television tower). In partial shade in dark, loamy soil, well drained. Estimated elevation ca. 3000 ft, 10 Aug 1972, T. M. Howard with James Bauml & Steve Lowe 72-70 (Holotype, RSA 240114; isotypes BM, G, MO, US, T. M. Howard herbarium). Other specimens examined were prepared from plants in cultivation: USA. PENNSYLVANIA: Annville, Lebanon Valley College greenhouse, 11 Aug 1975, S. Verhoek 882T (source: type locality, Howard et al 72-70 [Verhoek herbarium]. TEXAS: San Antonio, garden, TMH [T. M. Howard] s. n. (source: type locality, Howard et al 72-70 [RSA 240103]).

This species is distinctive in the genus Polianthes because only it and P. densiflora (B. L. Robinson & Fern.) Shinners have flowers solitary at the nodes and only in P. densiflora and P. nelsonii Rose is the mouth of the tube as asymmetrical. However, despite its similarities to these two species, P. howardii has closer affinity with the species in the section Bravoa because of its coral-red flowers and the insertion of its stamens at the base of the tube. The flowers of P. howardii are the most colorful of the bravoa group because the basal red grades to green at the mouth and the interior of the tepals and tube is often marked with maroon stripes.

The tubular red flowers of section Bravoa are typical examples of bird-pollinated flowers. The flower of P. howardii seems to be a variant of the classic pollination type. As in many other species in this section, the course of floral maturity in P. howardii is precisely timed and choreographed. The flowers are protandrous by two days. When the flower opens, the style is not fully elongated. At the same time, the stamens are at full length and held along the top of the tube so that the anthers are positioned at the top of the mouth of the flower (Fig. 1b). The anthers dehisce on the first day of bloom.

On the second day of bloom, the stamens begin to droop toward the bottom of the tube and the style continues to elongate along the top. On the third day, the stamens, with withered anthers, lie along the bottom of the tube and the style is extended a short way past the top of the tube, so that the reflexed lobes

of the receptive stigma are at, or slightly beyond, the position previously held by the newly opened anthers. One or two flowers open each day so that all stages of flowering are present on a single inflorescence. The progress of floral maturity seems to assure efficiency of pollination by the deposition and picking-up of pollen at the same spot on the body of the pollinator.

This multicolored species was discovered by Thad M. Howard, DVM, and his associates Steve Lowe and James Bauml, as they descended a small mountain in Colima. Additional field information supplied by Dr. Howard (personal correspondence) is as follows: "...from the hills of central Colima, growing near the top of a wooded hill in humusy black soil in part shade." In other correspondence he reports further that the type locality is approximately three-fourths of the way up the mountain, in oak woods on calcareous soil.

Thad Howard, during numerous expeditions to Mexico in search of attractive bulbous and tuberous plants, has collected many specimens for his own garden and has generously sent others for study at various institutions. It is a pleasure to name this striking Polianthes species in his honor.

Acknowledgment

I would like to thank Drs. William Dress and Harold E. Moore, Jr., L. H. Bailey Hortorium, Cornell University, for reading the manuscript and Dr. Dress for translating the Latin diagnosis.

NOTES ON GUATEMALAN SAPINDACEAE

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CUPANIA CLAVELLIGERA Lundell, sp. nov. — Arbor parva, ramulis velutino-pilosis; folia ad 20 cm. longa; foliola 5 vel 6, sessilis, obovata, oblanceolata vel elliptica, 4.5–18 cm. longa, 2–5.5 cm. lata, apice subacuminata, basi cuneata, supra glabrata, subtus pilosa, serrata, lamina chartacea; inflorescentia paniculata, velutino-pilosa, ad 25 cm. longa, pauciramosa; flores subspicati; pedicelli 0.5–0.8 mm. longi; bracteae subulato-lanceolatae, ad 2 mm. longae; sepala imbricata, pilosa, 2–2.5 mm. longa; petala unguiculata, 1.8–2.5 mm. longa, dentata, pilosa; filamenta ad 3.8 mm. longa, basi pilosa; antherae glabrae; ovarium dense pilosum.

Small tree, about 7 m. tall, conspicuously velutinous-pilose with tawny hairs; branchlets stout; leaves large, the petiole and rachis up to 10.5 cm. long; leaflets 5 or 6, sessile, chartaceous, obovate, oblanceolate or elliptic, 4.5–18 cm. long, 2–5.5 cm. wide, apex subacuminate, basi cuneate or acute, the margin remotely serrate, pilose at first on both surfaces, glabrate above except along the midvein, persistently pilose beneath; inflorescence large, paniculate, up to 25 cm. long, velutinous-pilose, few-branched; flowers pilose, subspicate, with the pedicels only 0.5–0.8 mm. long; bracts subulate-lanceolate, up to 2 mm. long; sepals imbricate, closed in bud, thin, pilose, elliptic or obovate, 2–2.5 mm. long; petals unguiculate, the claw clavate, the blade thin, the sides folded inward and spathe-like, pilose, the margin conspicuously dentate, 1.8–2.5 mm. long; filaments slender, up to 3.8 mm. long, pilose to above middle; anthers about 0.6 mm. long, glabrous; ovary pilose.

Guatemala: Dept. Izabal, El Estor, in high forest, March 25, 1972, Elias Contreras 11545 (LL, type), tree 20 ft. high, 4 in. diam., flowers creamish-white.

Closely related to *C. guatemalensis* (Turcz.) Radlk., the taxon differs in having only 5 or 6 usually obovate or oblanceolate leaflets which are sessile and mostly cuneate at base with margin remotely serrate.

The large inflorescences are few-branched with the flowers dense and essentially spicate. The flowers differ from those of C. guatemalensis in having smaller sepals, and dentate petals clavate below and spathe-like above.

MATAYBA VERAPAZENSIS (Lundell) Lundell, comb. nov. Cupania verapazensis Lundell, Wrightia 5: 2. 1972.

Guatemala: Dept. Baja Verapaz, Union Barrios, in high forest on top of hill, March 15, 1972, Elias Contreras 11333 (LL, type), tree, 80 ft. high, 20 in. diam., fruit reddish; same locality, in high forest on top of hill, west of km. 161/162, Aug. 20, 1975, C. L. Lundell & Elias Contreras 19700 (LL), tree, 35 ft. high, 6 in. diam., flowers greenish; Niño Perdido, in high forest, on top of hill, east of km. 150/151 of road, Aug. 20, 1975, Lundell & Contreras 19755 (LL), tree, 40 ft. high, 10 in. diam.

Described from fruiting specimens, flowers collected in 1975 have a 5-lobed calyx open in bud, hence the species is referable to Matayba.

HAPLOPAPPUS ENORMIDENS (COMPOSITAE), A NEW SPECIES FROM BAJA CALIFORNIA, MEXICO

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In June 1975 I found sterile plants of an unknown Haplopappus in the southwestern foothills of the Sierra San Pedro Mártir, Baja California. In habit this plant resembled H. vernicosus Brandegee, for which I mistook it from a distance; but the leaves were more like those of H. odontolepis Moran. I returned to the spot with Jack Reveal on July 19 and 20, to find the plant in late flower and early fruit. It proves to be a new species somewhat intermediate between H. vernicosus and H. odontolepis.

The new species is placed in Haplopappus section Hazardia as treated by Hall (1928). Clark (1975) compared Hazardia with Isocoma and Ericameria, also treated by Hall as sections of Haplopappus, and concluded that "Hazardia should be considered a distinct genus separate from Hall's other North American sections of Haplopappus". With his evidence, he may judge that Hazardia should be in a different genus from Isocoma and Ericameria, even though not all taxonomists will necessarily agree. From the evidence given, however, he cannot logically conclude that Hazardia should be considered a distinct genus, for he made no comparisons with the South American type species and typical section of Haplopappus.

Haplopappus odontolepis was described (Moran 1969) from flowering material, with no mature achenes. Although it seemed probable that the disk florets were fertile, a later collection shows them sterile.

I am grateful to Dr. Ray Jackson for making chromosome counts of several collections of Haplopappus species and for reviewing this manuscript.

Haplopappus enormidens Moran, species nova.

Fruticulus hispidulus resinosus 1-3 dm altus. Folia sessilia elliptica acuta irregularissime spinoso-dentata plerumque 6-10 mm longa et 2-3 mm lata. Capitula solitaria vel pauca cymosaque, involucro cylindrico 9-12 mm longo et 2-3 mm lato, bracteis 16-21 squarrosis. Flores radii 3-6 fertiles, ligulis 3-4 mm longis. Flores disci 5-11 steriles. Achenia obcompressa cuneata 3-4 mm longa, pappo 4-6 mm longo. Typus: Moran et Reveal 22602 (SD 91522). Species H. odontolepidi similis, sed foliis capitulisque minoribus, bracteis uninervibus, et floribus paucioribus minoribusque.

Shrublet 1-3 dm high and 2-7 dm wide, much branched from base, hispidulous with conic white trichomes ca. 0.05 mm long, resinous, with odor recalling turpentine. Branchlets flexuous, 0.5-1.0 mm thick, angled from leaf margins and midrib downwards, sparsely hispidulous, light green soon becoming tan, gray in age, leafy, mostly with small few-leaved fascicles in axils, the internodes averaging ca. 3-6 mm. Leaves ascending, sessile and subclasping-decurrent, elliptic to oblong, acute, 6-10 (-14) mm long, 2-3 (-5) mm wide above, 1-2 mm wide at base, coriaceous, glandular-pitted and slightly to heavily resinous, moderately hispidulous either mostly near margins or throughout, the midrib inconspicuously projecting dorsally, gibbous at base, not discernible ventrally, the lateral veins obscure, the apex deflexed, tipped with a white spine to ca. 0.5 mm long, the margins entire or with 1-9 very irregularly spaced spreading or slightly ascending white spinose teeth ca. 0.2-0.5 mm long. Heads yellow, solitary at ends of branchlets or cymose with 1-4 more on peduncles 1-12 mm long from upper axils. Involucre cylindric or subfusiform, shorter than disk, 9-12 mm long, 2-3 mm thick exclusive of squarrose tips; bracts 16-21, firm-chartaceous, 1-nerved, the outer 10 or so well graduated with lower passing into leaves, ca. 2 mm wide, the exposed upper 2-4 mm herbaceous, glandular-pitted, often with 1-4 marginal teeth, ciliate below, the spinose tip outcurved; inner ones subequal, linear, acute, erose-ciliate above, the outer of these ca. 2 mm, the inner ca. 1 mm wide. Ray florets 3-6, fertile; ovary 2-3 (-5) mm long; corolla 7.5-11 mm long, the ligule elliptic, scarcely toothed at apex, 3-4 mm long, 1.0-1.3 mm wide; style branches 0.6-1.4 mm long, stigmatic full length. Disk florets 5-11, sterile; ovary 2-3 (-5) mm long; corolla 7-9 mm long, slender, slightly ampliate from middle, the teeth 0.6-0.8 mm long; style branches 1-2 mm long, puberulent throughout, lacking evident stigmatic lines. Achenes obcompressed, cuneate, 3-4 mm long, ca. 1 mm wide, grayish, ascending strigose with trichomes ca. 0.2 mm long, mostly with 5 rather strong white nerves, one on axial side often prominent; pappus 4-6 mm long, of ca. 45-55 scabrous bristles. Chromosomes: $2n=10$.

Type: Ridge 5 km southwest of San Isidoro (7.5 km by road), elevation ca. 1170 m, southwestern foothills of the Sierra San Pedro Mártir, Baja California Norte, México (near 30°44'N, 115°34'W), 19 July 1975, Reid Moran & Jack Reveal 22602; holotype, SD 91522; isotypes to go.

Distribution: Known only from the vicinity of the type locality (Moran 22343, Moran & Reveal 22606) and from about 40 km to the south-southeast, south of Rancho San Miguel, at 975 to 1175 m elevation (Moran 19511, 22640); all SD and to go.

At the type locality H. enormidens is abundant on a slight north slope in open areas at the edge of chaparral and especially in an open stand of Juniperus californica Carr. It was seen for about 2 km along the road, replaced rather abruptly by H. vernicosus both to the east and to the west. At the zone of contact we found a few intermediate plants that appear to be hybrids (22607); and from buds collected there for H. enormidens (22606) Dr. Jackson, though he got no chromosome count, reports the pollen size very unequal and the plant probably somewhat sterile. South of Rancho San Miguel H. enormidens is common on a mesa with Adenostoma fasciculatum H. & A. and Juniperus californica and occasional down the north slope; there H. vernicosus occurs at a lower elevation, and the two were not seen together.

Haplopappus enormidens is named for the very irregular distribution of teeth on the leaf margins: there may be three on one side and none on the other, or one near the base on one side and two near the apex on the other, or none at all, or up to nine—and all in leaves of one branch. In H. odontolepis the distribution of teeth is somewhat irregular but less markedly so.

Haplopappus enormidens is like a small form of H. odontolepis, with thinner stems, smaller leaves, smaller heads, and fewer and smaller florets. That species is now known from three peaks—Cerro Matomí, Cerro Potrero, and Cerro Santo Tomás—in a span of 100 km along the peninsular divide of Baja California, at about 1150 to 1450 m; the northernmost is about 25 km east of the southern locality for H. enormidens. Where H. enormidens differs from H. odontolepis, it often approaches H. vernicosus—which is abundant in the foothills from north of San Vicente to southeast of El Rosario, at about 50 to 1200 m. The three species are distinguished in the following key.

A. Involucres 9-13 mm long; ovaries of (sterile) disk florets equalling those of ray florets; leaves sessile, gradually narrowed to the subclasping base, toothed but not lobed.

B. Ray florets 6-8, the ligules 5-6.5 mm long; disk florets 11-15; involucres 3-5 mm thick, of ca. 25-30 several-nerved bracts. . . . . H. odontolepis.

BB. Ray florets 3-6, the ligules 3-4 mm long; disk florets 5-11; involucres 2-3 mm thick, of 16-21 one-nerved bracts . . . . H. enormidens.

AA. Involucres 6-7 mm long; ovaries of (sterile) disk florets half as long as those of ray florets; leaves narrowed, often abruptly, to petiole-like base, the blade lobed a third or half way to midrib . . . . H. vernicosus.

These three species are placed in section Hazardia. For the collection of H. enormidens from San Miguel (22640), Dr. Jackson reports a somatic chromosome count of 2n=10, agreeing with counts for H. vernicosus and other members of the section. Within the section, however, these three form a distinct group marked by sterile disk florets, toothed outer involucral bracts, and obcompressed achenes—all characters rare or unique in the genus—and further characterized by a low bushy habit and small toothed resinous leaves. The three form a series, with H. odontolepis most like other members of the section and H. vernicosus most reduced and divergent. Thus H. vernicosus differs from H. odontolepis in having (1) smaller leaves, narrowed to a petiole-like base rather than broad and subclasping; (2) smaller heads, with fewer bracts and fewer and smaller florets; (3) one-nerved rather than several-nerved bracts; (4) the ovary of the disk florets half as long as that of the ray florets rather than as long; and (5) stigma lobes of the disk florets lacking stigmatic lines. Haplopappus enormidens is intermediate in size of leaves and heads and in number and size of florets; it is like H. odontolepis in leaf shape and in relative size of disk ovaries; and it is like H. vernicosus in having one-nerved bracts and in lacking stigmatic lines in the disk florets.

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STUDIES IN THE EUPATORIEAE (ASTERACEAE). CLX.

A NEW SPECIES OF SCIADOCEPHALA FROM ECUADOR.

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The genus *Sciadocephala* has been revised and enlarged in two recent studies from a single species to four species (King & Robinson, 1974, 1975). A fifth undescribed species has now been seen from the Napo-Pastaza area of Ecuador. The new species is the second having a repent habit being closely related to *S. pakaraimae* (Maquire & Wurdack) K & R of British Guiana. The species from British Guiana differs most notably by the 13-15 flowers per head with corollas only about 5 mm long. The leaves also differ by the generally smaller size with more crenulate-serrate margins and by the smaller denser pilosity of the upper surface. The hairs of the peduncle, involucral bracts, and corollas are not gland-tipped in *S. pakaraimae* while the hairs in the new species are larger with small but distinct glandular tips.

Sciadocephala asplundii R.M.King & H.Robinson, sp. nov. Plantae herbaceae repentes. Caules virides pilosi, pilis rufescentibus, internodis usque ad 8 cm longis. Folia opposita, petiolis 5-17 mm longis peranguste alatis; laminae late ovatae vel suborbiculares 4-6 cm longae 3.5-5.0 cm latae base abrupte late rotundatae margine utrinque 8-12 argute serratae apice obtuse acutae supra persparse grosse pilosae subtus plerumque in nervis puberulae, nervis secundariis paucis utrinque 2 valde ascendentibus basalioribus essentialiter trinervatis. Inflorescentiae terminales non ramosae unicapitatae, pedunculis ca. 8 cm longis dense glandulo-hirsutis, bracteis basilaribus foliosis late ovatis 2.0-2.5 mm longis et ca 2 mm latis, bracteis mediis minutis ca. 6 mm longis et 2 mm latis dense glandulo-hirsutis. Capitula 2.3 cm alta et 1.2-1.5 cm lata; squamae involucri ca 15 anguste oblongae 5-8 mm longae et 1.0-1.5 mm latae biseriatae dense glandulo-hirsutae apice obtusae base vix connatae. Flores ca. 10. Corollae albae tubiformes 18 mm longae extus sparse minute puberulae in 2/3 superiore sparse glandulo-pilosae, tubis indistinctis, lobis breviter triangularibus ca. 0.7 mm longis et 0.8 mm latis; filamenta antherarum in parte superiore ca. 0.6 mm longa; thecae

ca. 3 mm longae; appendices ca. 0.3 mm longae et latae; styli glabri, appendicibus linearibus. Achenia immatura 4 mm longa puberula; clavulae pappi 5 immaturae ca. 1.5 mm longae; partibus glanduliferis discretis ca. 0.4 mm longis. Grana pollinis spinosa ca. 30μ diam.

TYPE: ECUADOR: Napo-Pastaza: Mera, forest towards Mangayacu, alt. c. 1,100 m. 9. III. 1956. Flowers white. Erik Asplund 19675 (Holotype S).

References

King, R. M. & H. Robinson. 1974. Studies in the Eupatorieae (Asteraceae). CXXVII. Additions to the American and Pacific Adenostemmatinae. *Adenostemma*, *Gymnocoronis* and *Sciadocephala*. Phytologia 29: 1-20.

______ & ______ 1975. Studies in the Eupatorieae (Asteraceae). CXXXIV. A new species of *Sciadocephala* from Panama. Phytologia 29: 343-346.

Dr. Rogers McVaugh has kindly pointed out that the species, *Revealia stevioides* K. & R. is the same as the previously described *Oxylobus macrocephalus* Paray. The type has been borrowed through the kindness of the Herbario Nacional de Mexico and the identity confirmed. The following new combination is necessary.

Revealia macrocephala (Paray) R.M.King & H.Robinson, comb. nov. *Oxylobus macrocephalus* Paray, Bol. Soc. Bot. Mex. 22:1. 1958. Mexico.

Sciadocephala asplundii R.M.King & H.Robinson, Holotype, Riksmuseum, Stockholm. Photos by Victor E. Krantz, Staff Photographer, National Museum of Natural History.

STUDIES IN THE LIABEAE (ASTERACEAE). VI.

NOTES ON THE GENUS *ERATO*

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In a survey of the genera of the Liabeae (Robinson and Brettell, 1974) *Erato* DC. was treated as a subgenus of *Munnozia* in spite of a distinctive appearance and one known significant specialization. An effort was made to maintain the generic concepts as broad as possible. During the recent efforts to revise the Liabeae of Ecuador the distinct nature of *Erato* has become more obvious. The genus exceeds a number of limits that characterize typical *Munnozia* and the other subgenus, *Kastnera*. *Erato* approaches *Philoglossa* in achene structure and pubescence and seems to relate more closely to that genus.

The most notable features of *Erato* are the achene and the pubescence. The achene usually has four ribs or sides, occasionally only three. Such achenes seem intermediate in a reduction series between the 6-10 ribs in *Munnozia* and the 2-sided achenes found in *Philoglossa*. The pubescence in *Erato* consists of stiff hairs having short thick basal cells. Tomentum is almost completely lacking, being found only on the tips of the phyllaries in three of the four species. Such pubescence is similar to that in *Philoglossa* and differs from that in *Munnozia*.

Additional distinctions are found in *Erato*. The leaves are totally unique in the 5-11 palmately radiating veins of the blade. The rays in the heads are extremely numerous in many rows, and they exceed the number of disk flowers. The limbs of the rays are essentially glabrous while the limbs in *Munnozia* usually have glands or hairs extending onto the upper part. The disk corollas have sharp spicules on the tips of the lobes, a condition found in one species of *Philoglossa* but not in any species of *Munnozia*. The characteristic pappus of *Erato* is a series of spreading rather persistent tapering setae in contrast to the less spreading less tapering setae of *Munnozia*. One species of *Erato* has a reduced pappus which differs even more from that of *Munnozia*.

On the basis of the differences cited, *Erato* is here restored to generic status. The type species, *E. polymnioides* reverts to its original name while

three others require new combinations. A fifth species from Ecuador, Liabum anatina Benoist, included in the generic survey now seems to be conspecific with the widely distributed E. vulcanica of Colombia, Costa Rica and Venezuela. The four species of Erato are as follows.

Erato polymnioides DC., Prodr. 5: 318. 1836. Synonym: Liabum pallatangense Hieron., Engl. Bot. Jahrb. 29: 60. 1900.

Erato sodiroi (Hieron.) H.Robinson, comb. nov. Liabum sodiroi Hieron., Engl. Bot. Jahrb. 29: 61. 1900.

Erato stenolepis (Blake) H.Robinson, comb. nov. Liabum stenolepis Blake, Journ. Wash. Acad. Sci. 17: 302. 1927.

Erato vulcanica (Klatt) H.Robinson, comb. nov. Liabum vulcanicum Klatt, Engl. Bot. Jahrb. 8: 302. 1927. Synonym: Liabum anatina Benoist, Bull. Soc. Bot. France 84: 633. 1938.

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Robinson, H. and R. D. Brettell 1974. Studies in the Liabeae (Asteraceae). II. Preliminary survey of the genera. Phytologia 28: 43-63.

STUDIES IN THE LIABEAE (ASTERACEAE). VII.

ADDITIONS TO THE GENUS MUNNOZIA.

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Efforts to revise the Liabeae of Ecuador have resulted in the discovery of three undescribed species of Munnozia, one each from Colombia, Ecuador and Peru. The Ecuadorian species belongs to the subgenus Kastnera, the Colombian species is notable for the long outer involucral bracts, and the Peruvian species is unique in the genus by the complete lack of pappus setae.

Munnozia (Kastnera) asplundii H.Robinson, sp. nov.

Plantae herbaceae perennes decumbentes vel subscandentes 60 cm vel ultra longae. Caules rubrescentes teretes vel striati pilosi. Folia base non connata, petiolis 1.5-4.0 cm longis late alatis margine argute dentatis base latioribus et valde auriculatis; laminae herbaceae ovatis 3-9 cm longae et 1.5-6.5 cm latae base cordatae ex alis petioli fere discontinuae margine utrinque 5-10 dentatae vel duplo-dentatae apice acutae supra sparse grosse pilosae subtus tenuiter canescentiter tomentosae, nervis secundariis in basis congestis, nervis subtus flaccide pilosis. Inflorescentiae plerumque in apicibus ramorum ternatae, pedicellis usque ad 8 cm longis dense longe pilosis, pilis flaccidis non glandulosis. Capitula 10-11 mm alta et 13-18 mm lata; bracteae involucri 20-24 oblongo-ovatae vel oblongo-lanceolatae ca. 7 mm longae et 1.0-3.3 mm latae 2-3-seriatae margine puberulae vel minute serrulatae anguste scariosae apice acutae purpurascentes extus inferne sparse pilosae superne minute stipitato-glanduliferae; receptacula minute puberula vel glabrescentia. Flores radii ca. 16; corollae flavae, tubis 3.5 mm longis pilosis, limbis 15-25 mm longis et 2.5 mm latis in 2/3 inferioribus piliferis apice leniter emarginatis. Flores disci ca. 30; corollae flavae, tubis 3-5 mm longis superne piliferis, faucis valde abruptis 1 mm longis glabris, lobis 3 mm longis 0.6-0.7 mm latis superne sensim piliferis; filamenta in parte superiore ca. 0.4 mm longa; thecae ca. 2 mm longae, cellulis exothecialibus in parietibus lateralibus et transversalibus noduliferis; appendices 0.45-0.50 mm longae ovatae acutae. Achaenia immatura ca.

1.5 mm longa dense setifera ca. 8-costata; squamae pappi laceratae ca. 0.6 mm longae inferne breviter connatae, setae plerumque 5 ca. 3 mm longae apice decrescentes. Grana pollinis 35-37 μ diam.

TYPE: ECUADOR: Pichincha: NW slope of Mt. Corazón, alt. c. 3150 m. Decumbent or climbing herb, flowers golden yellow. 27 July 1955. Asplund 17087 (Holotype S).

Munnozia asplundii is most closely related to M. acostae (Chung) R.& B. which proves to be a member of the subgenus Kastnera. The new species is distinct by the more ovate leaf blades having cordate bases that are separated from the petiole wings by a narrow sinus, and the undersurface of the blade is thinly tomentose. In M. acostae the leaf blades are triangular with truncate or hastate bases and the undersurface has no tomentum.

Munnozia ferreyrii H.Robinson, sp. nov.

Plantae herbaceae perennes erectae vel procumbentes 30-70 cm longae. Caules rubrescentes teretes vel striati pilosi. Folia base in disco connata, discis 1-2 cm latis, petiolis 7-17 mm longis distincte anguste alatis; laminae herbaceae triangulari-ovatae 2.0-4.5 cm longae et 1.5-4.5 cm latae base truncatae margine pauce breviter dentatae apice breviter acutae supra pilosae subtus canescentiter tomentosae, ex apice petioli valde trinervatae subtus in nervis primariis pilosae. Inflorescentiae laxe cymosae pauce alternate ramosae, pedicellis 2-7 cm longis dense pilosis. Capitula 7-9 mm alta et 5-10 mm lata; bracteae involucri 20-24 oblongo-ovatae vel oblongo-lanceolatae 2.5-5.0 mm longae et 1.0-1.5 mm latae 2-3-seriatae margine integrae anguste scariosae apice acutae purpurascentes extus dense pilosae; receptacula ignota. Flores radii 12-13; corollae flavae, tubis ca. 2 mm longis piliferis, limbis 12-14 mm longis et 1.5-2.0 mm latis extus sparse glanduliferis inferne piliferis apice leniter emarginatis. Flores disci 12-13; corollae flavae, tubis ca. 2 mm longis piliferis, faucis abruptis 1.5-1.8 mm longis base piliferis, lobis ca. 1.8 mm longis ca. 0.5 mm latis extus sparse glandulo-punctatis apice glabris vix papillosis; filamenta in parte superiore ca. 0.3 mm longa; thecae 2 mm longae, cellulis exothecialibus in parietibus laterialibus raro noduliferis; appendices ovatae vel oblongae ca. 0.25 mm longae et 0.2 mm latae apice subtruncatae. Achaenia ca. 3 mm longa et ca. 1 mm lata puberula 6-costata; squamae pappi minute usque ad 0.25 mm longae plerumque connatae denticulatae, setae nullae. Grana pollinis 27-33μ.

TYPE: PERU: Cajamarca: Celendin, Gorge of Rio Marañon 3-4 km below summit of road to Celendin, above Balsas, alt. 2950 m. Herb. Lvs. amplexicaul, upper face medium green, white villous; under face pale green, pubescent. Fls. bright yellow. 21 May 1964. Hutchison & Wright 5234 (Holotype US).

The new species has a reduced habit and a pappus with short squamae, both reminiscent of the subgenus Kastnera. The exothecial cells are like those of M. sagittata (Sch.Bip.) R.& B. in the subgenus Munnozia, however. Fused foliar disks on the nodes also seem foreign to the subgenus Kastnera. Examination has shown no evidence of pappus setae, a condition unique in the genus. Short pappus squamae are present but these are shorter than those in the subgenus Kastnera and are not obvious in fully mature achenes. The six-ribbed achenes also seem distinctive. Achenes in Munnozia usually have 8-10 ribs.

Munnozia fosbergii H.Robinson, sp. nov.

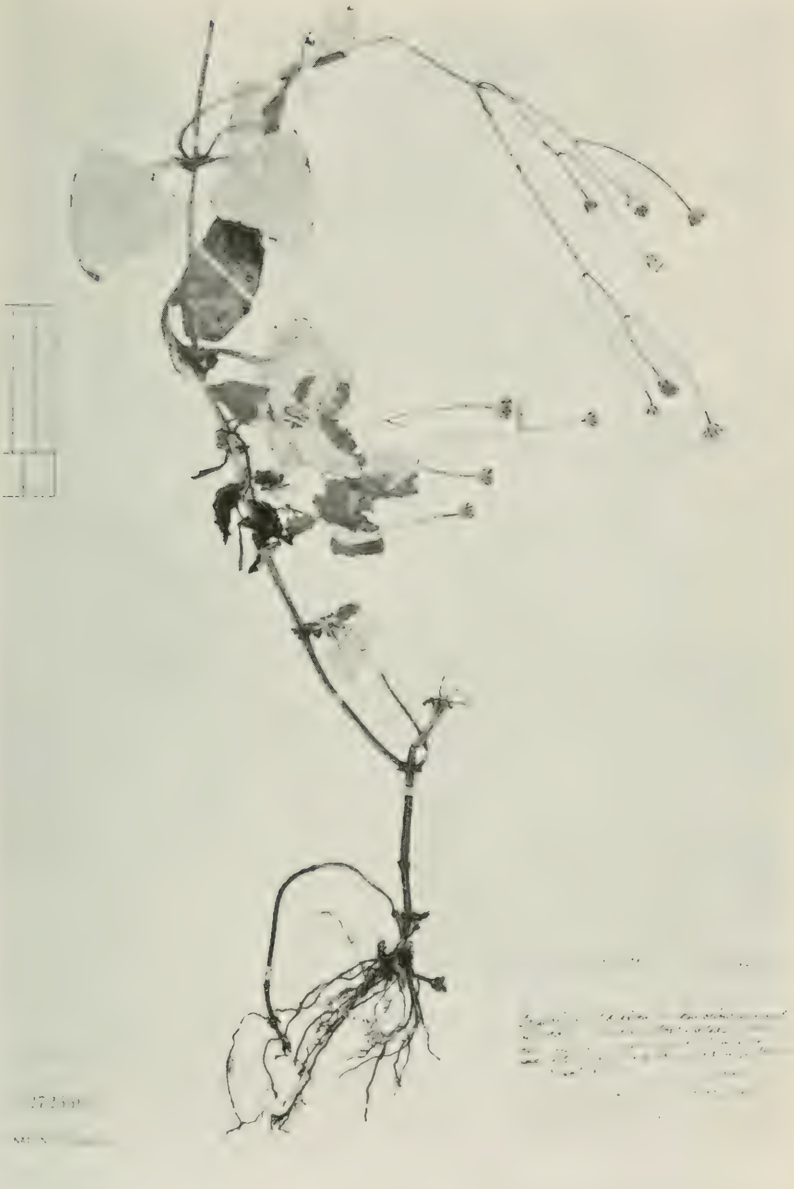
Plantae herbaceae perennes erectae ca. 7 dm altae base decumbentes. Caules subtiliter rubrescentes sexangulares evanescentiter arachnoideo-tomentosi. Folia base in disco connata, discis 1.5-2.0 cm latis, petiolis 2-4 cm longis alatis, alis utrinque 2-5 mm latis remote 2-4-denticulatis; laminae herbaceae deltoideae vel 5-angulatae 3-8 cm longae et 2-5 cm latae base truncatae margine utrinque remote minute 3-10-denticulatae apice argute acutae vel vix acuminatae supra sparse pilosae subtus tenuiter canescentiter tomentellae, nervis e basis distincte trifidis, nervis lateralibus valde ascendentibus, nervis subtus flaccide pilosis. Inflorescentiae plerumque in apicibus ramorum ternatae, pedicellis 4-6 cm longis arachnoideo-tomentosae. Capitula 10-12 mm alta et plerumque 12-15 mm lata; bracteae involucri 22-25 bi-tri-seriatae 5-6 exteriores oblanceolatae 12-13 mm longae acutae margine tomentosae extus sparse evanescentiter arachnoideo-tomentosae interiores oblongo-lanceolatae vel anguste lanceolatae 9-10 mm longae glabrae anguste acutae; receptacula minute squamulifera. Flores radii ca. 20; corollae flavae, tubis 2.5-3.0 mm longis superne pilosis, limbis 15-18 mm longis et 1.7 mm latis inferne dense pilosis superne stipitate glanduliferis. Flores disci ca. 23; corollae flavae, tubis 3.5-5.0 mm longis sparse piliferis, faucis abruptis 2.0-2.5 mm longis inferne dense piliferis, lobis ca. 2 mm longis et 0.4-0.5 mm latis extus stipitate glanduliferis saepe in apice pilis noneglandulosis unicis; filamenta in parte superiore ca. 0.4

mm longa; thecae 2.5 mm longae, cellulis exothecialibus solum in parietibus transversalibus noduliferis; appendices 0.4 mm longae et 0.15 mm latae oblongae apice rotundatae. Achaenia immatura 1.5 mm longa superne setifera ca. 10-costata; setae pappi ca. 30-32 plerumque 6-7 mm longae apice vix decrescentes, squamae nullae. Grana pollinis 35-37μ diam.

TYPE: COLOMBIA: Boyaca: Buenavista, headwaters of Río Pauto, ridge e. of Quebrada Laja (Q. Colorada), 30 km e.s.e. of Socha, Lat. 5°55' N., Long. 72°28' W. New clearing, cloud forest on steep slopes, alt. 2700-2900 m. Sap milky, fls. yellow. 10 Nov. 1944. Fosberg 22262 (Holotype US).

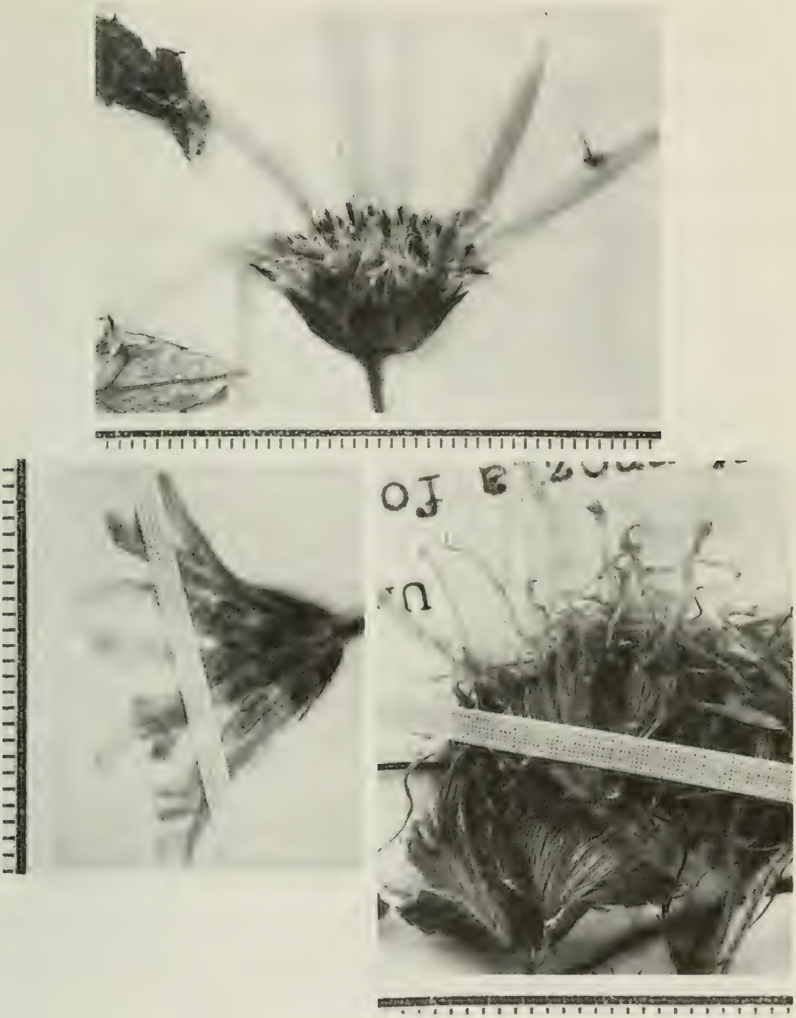
The new species has the general aspect of the common *Munnozia sagitata*, but it is immediately distinguished by the broadly connate bases of the leaves. The involucre is also distinctive and unique in the genus by the enlarged outer bracts.

Munnozia asplundii H.Robinson, Holotype, Riksmuseum, Stockholm. Photos by Victor E. Krantz, Staff Photographer, National Museum of Natural History.



Munnozia ferreyrii H.Robinson, Holotype, United States National Herbarium.

Munnozia fosbergii H.Robinson, Holotype, United States National Herbarium.



Enlargements of heads of Munnozia. Top; *M. asplundii*. Bottom left; *M. ferreyrii*. Bottom right; *M. fosbergii*.

A New Form of *Alyxia olivaeformis* Gaud.

(Apocynaceae). Hawaiian Plant Studies 50

Harold St. John
(Bishop Museum, Honolulu, Hawaii 96818, USA)

Alyxia olivaeformis Gaud., forma **retusa**, forma nova. Fig. 1.

Diagnosis Holotypi: Foliis oppositis vel ternatis, laminis 19-38 mm longis 16-28 mm latis obovatis retusis marginibus revolutis, umbellis 2-2.5 cm longis, corollis 6 mm longis.

Diagnosis of Holotype: Leaves opposite or ternate; petioles 2-3 mm long; blades 19-38 mm long, 16-28 mm wide, coriaceous, obovate, the apex retuse, the base shortly cuneate, the margins revolute, the blade shiny, above dark green, below green; umbels 2-2.5 cm long; corollas 6 mm long.

Holotypus: Hawaiian Islands, Kauai Island, Napali Coast, Hanakapiai Valley, on ridge e. of the stream, dryland forest, 800 ft alt., Aug. 28, 1976, *Charles Christensen* 61 (BISH).

Discussion: The writer distinguished (Phytologia 32: 377-386, 1975) eleven forms of this species. Only one of them, forma *obovata*, has the blades obovate, but it has the apex rounded or subacute. The new forma also has obovate blades, but it unique in having the blade apices retuse. The epithet *retusa* has been used before, as *A. retusa* Merr., for a species from Luzon (Philipp. Journ. Sci. 14: 448, 1918), but that does not prevent its use in the taxon forma. It is inconceivable that any botanist would raise this forma to the status of a species, and locally it is outstanding in its retuse blades.

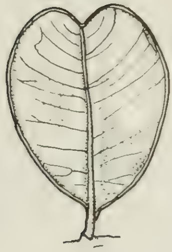


Fig. 1. Alyxia olivaeformis Gaud., forma retusa St. John, from holotype. Leaf X 1.

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NOTES ON NEW AND NOTEWORTHY PLANTS. XCII

Harold N. Moldenke

PREMNA MARIANNARUM f. DENTATA Moldenke, f. nov.

Haec forma a forma typica speciei foliorum laminis margine grossedentatis recedit.

This form differs from the typical form of the species in having the margins of its leaf-blades coarsely dentate with rounded or obtuse, rather low, sparse teeth.

The type of the form was collected by M. V. C. Falanruw (no. 3132) in a shrubby area along the southwest coast of Guguan island, northern Marianas Islands, at an elevation of about 9 meters, on July 12, 1975, and is deposited in the United States National Herbarium at Washington.

ADDITIONAL NOTES ON THE ERIOCAULACEAE. LXIII

Harold N. Moldenke

ERIOCAULACEAE Lindl.

Additional & emended bibliography: C. Müll. in Just, Bot. Jahresber. 16 (1): 769—770. 1888; Holm, Bot. Gaz. 31: 17—37, fig. 1—5. 1901; Pilger in Engl. & Prantl, Nat. Pflanzenfam. Ergänz. 2, Nachtr. 3 zu 2: 37—41, fig. 6 & 7. 1908; Lutz & Machado, Mem. Inst. Oswaldo Cruz 7: 15. 1915; Gleason, Bull. Torrey Bot. Club 58: 327—330. 1931; Macbr., Field Mus. Publ. Bot. 11: 8. 1931; Gleason, New Britt. & Br. Illustr. Fl., imp. 1, 1: 372 & 479 (1952) and imp. 1, 3: 561, 568, & 582. 1952; Sonohara, Tawada, & Amano [ed. E. H. Walker, Fl. Okin. 205. 1952; Duvigneaud, Lejeunia 16: 103. 1953; Gleason, New Britt. & Br. Illustr. Fl., imp. 2, 1: 372 & 479 (1958), imp. 2, 3: 561, 568, & 582 (1958), imp. 3, 1: 372 & 479 (1963), and imp. 3, 3: 561, 568, & 582. 1963; Moldenke, Act. Bot. Venez. 2: 153. 1967; Bolkh., Grif, Matvej., & Zakhar., Chrom. Numb. Flow. Pl., imp. 1, 274. 1969; G. W. Thomas, Tex. Pl. Ecolog. Summ. 32. 1969; Whitehead, Ann. Mo. Bot. Gard. 59: 132 & 133. 1972; Thorne in Meggers, Ayensu, & Duckworth, Trop. Forest Ecosyst. Afr. & S. Am. 29 & 30. 1973; Bolkh., Grif, Matvej., & Zakhar., Chrom. Numb. Flow. Pl., imp. 2, 274. 1974; Napp-Zinn, Anat. Blat. 969, 1085, 1157, & 1340. 1974; Beecher, Exxon USA 14 (4): 29. 1975; Greller, Bull. Torrey Bot. Club 102: 415. 1975; Hocking, Excerpt. Bot. A.26: 6, 89, & 90. 1975; Schinini, Bol. Soc. Argent. Bot. 16: 351. 1975; Weberling & Schwantes, Pflanzensyst., ed. 2 [Ulmer, Uni-Taschenb. 62:] 161 & 375. 1975; Moldenke, Phytologia 32: 487—511, fig. 1 & 2 (1975) and 33: 9—58, 130—153, 183—202, 271—275, 373—374, 480, & 509—511. 1976; Jaeger, Boissiera 24: 474. 1976; Liogier, Bol. Jard. Bot. Raf. Moscoso 3 (2): 2. 1976; P. Morat, Adansonia, ser. 2, 15: [463]—469, pl. 1 & 2. 1976.

It should be noted here that the "Index Londinensis" gives "1906" as the proper publication date for the Pilger work cited above.

Macbride (1931) feels that Syngonanthus, Blastocaulon, Philodice, and Lachnocaulon should all be united in one genus, Paepalanthus, "as genera [which] constitute therefore from a purely disinterested standpoint one natural genus". In this opinion I do not concur.

BLASTOCAULON Ruhl.

Additional bibliography: Pilger in Engl. & Prantl, Nat. Pflanzenfam. Ergänz. 2, Nachtr. 3 zu 2: 37—39, fig. 6. 1908; Macbr., Field Mus. Publ. Bot. 11: 8. 1931; Hocking, Excerpt. Bot. A.26: 89. 1975; Moldenke, Phytologia 32: 460—461 (1975) and 32: 507. 1976.

Stapf (1930) dates the Pilger work referred to above as "1906". Macbride (1931) feels that Blastocaulon, along with Syngonanthus,

Philodice, and Lachnocaulon, should be united in Paepalanthus as a single genus.

BLASTOCAULON ALBIDUM (G. Gardn.) Ruhl.

Additional bibliography: Pilger in Engl. & Prantl, Nat. Pflanzenfam. Ergänz. 2, Nachtr. 3 zu 2: 39. 1908; Moldenke, Phytologia 29: 82. 1974; Hocking, Excerpt. Bot. A.26: 89. 1975.

BLASTOCAULON PROSTRATUM (Körn.) Ruhl.

Additional bibliography: Pilger in Engl. & Prantl, Nat. Pflanzenfam. Ergänz. 2, Nachtr. 3 zu 2: 39. 1908; Moldenke, Phytologia 29: 82. 1974; Hocking, Excerpt. Bot. A.26: 89. 1975.

BLASTOCAULON RUPESTRE (G. Gardn.) Ruhl.

Additional bibliography: Pilger in Engl. & Prantl, Nat. Pflanzenfam. Ergänz. 2, Nachtr. 3 zu 2: 28 & 39, fig. 6. 1908; Hocking, Excerpt. Bot. A.26: 89. 1975; Moldenke, Phytologia 32: 461. 1975.

Additional illustrations: Pilger in Engl. & Prantl, Nat. Pflanzenfam. Ergänz. 2, Nachtr. 3 zu 2: 39, fig. 6. 1908.

It should be noted here, again, that Stapf (1930) gives "1906" as the actual date of publication of the Pilger work (1908) cited above, but the Library of Congress (Washington) printed card for the work retains the 1908 title-page date.

BLASTOCAULON SPELEICOLA Alv. Silv.

Additional bibliography: Moldenke, Phytologia 29: 82. 1974; Hocking, Excerpt. Bot. A.26: 89. 1975.

CARPTOTEPALA Moldenke

Additional synonymy: Cartpotepala Morat, Adansonia, ser. 2, 15: 466. 1976.

Additional bibliography: Hocking, Excerpt. Bot. A.26: 89. 1975; Moldenke, Phytologia 32: 461 (1975) and 32: 507. 1976; P. Morat, Adansonia, ser. 2, 15: 466. 1976.

CARPTOTEPALA JENMANI (Gleason) Moldenke

Additional bibliography: Hocking, Excerpt. Bot. A.26: 89. 1975; Moldenke, Phytologia 32: 461. 1975.

COMANTHERA L. B. Sm.

Additional bibliography: Hocking, Excerpt. Bot. A.26: 89. 1975; Moldenke, Phytologia 32: 461 (1975) and 32: 508. 1976; P. Morat, Adansonia, ser. 2, 15: 466. 1976.

COMANTHERA KEGELIANA (Körn.) Moldenke

Additional & emended bibliography: Ruhl. in Engl., Pflanzenreich 13 (4-30): 271, 273, 290, & 293. 1903; Moldenke, Known Geogr. Distrib. Erioc. 7, 30, 50, & 58. 1946; Moldenke, Phytologia 4: 322. 1953; Moldenke, Résumé Suppl. 1: 5, 16, 21, 23, 25, & 26 (1959) and 14: 10. 1966; Hocking, Excerpt. Bot. A.26: 89. 1975; Moldenke, Phytologia 32: 461. 1975.

The Lockhart s.n. [Caracas] collection, previously cited (and repeated below), is a mixture with Syngonanthus gracilis (Bong.) Ruhl. Sandwith, in a communication to me dated May 12, 1956, has verified that this collection was actually made at or near to Caracas.

Emended citations: VENEZUELA: Federal District: Lockhart s.n. [Caracas] in part (K).

ERIOCAULON Gron.

Additional & emended bibliography: Holm, Bot. Gaz. 31: 17--37, fig. 1--5. 1901; Pilger in Engl. & Prantl, Nat. Pflanzenfam. Ergänz 2, Nachtr. 3 zu 2: 37 & 38. 1908; Gleason, New Britt. & Br. Illustr. Fl., imp. 1, 1: 372, 373, & 479 (1952) and imp. 1, 3: 562. 1952; Sonohara, Tawada, & Amano [ed. E. H. Walker], Fl. Okin. 205. 1952; Gleason, New Britt. & Br. Illustr. Fl., imp. 2, 1: 372, 373, & 479 (1958), imp. 2, 3: 562 (1958), imp. 3, 1: 372, 373, & 479 (1963), and imp. 3, 3: 562. 1963; G. W. Thomas, Tex. Pl. Ecolog. Summ. 32. 1969; Bolkh., Grif, Matvej, & Zakhar., Chrom. Numb. Flow. Pl., imp. 1, 274. 1969; Whitehead, Ann. Mo. Bot. Gard. 59: 132 & 133. 1972; Bolkh., Grif, Matvej., & Zakhar., Chrom. Numb. Flow. Pl., imp. 2, 274. 1974; Napp-Zinn, Anat. Blat. 969, 1157, & 1340. 1974; Beecher, Exxon USA 14 (4): 29. 1975; Greller, Bull. Torrey Bot. Club 102: 415. 1975; Hocking, Excerpt. Bot. A.26: 89 & 90. 1975; Moldenke, Phytologia 32: 488--506, 508, 509, & 511 (1975) and 33: 9--20, 130, 131, 135, 151, 153, 183--186, 189--191, 200, 201, 274, 275, 373--374, 508, & 509. 1976; P. Morat, Adansonia, ser. 2, 15: [463] & 464. 1976.

It should be noted here, again, that Stapf (1930) regards "1906" as the correct date of publication for the Pilger work (1908) cited above.

ERIOCAULON ABYSSINICUM Hochst.

Additional bibliography: Hocking, Excerpt. Bot. A.26: 89. 1975; Moldenke, Phytologia 32: 463. 1975.

ERIOCAULON ACHITON Körn.

Additional bibliography: Moldenke, Phytologia 32: 463 & 466. 1975.

Maxwell encountered this plant "in open wet marshy zone on bare rock" in Thailand and refers to the heads as grayish and the anthers black, while Hooper & Gandhi state that it is a "common" herb "in full sun in marshy ground" in India, the heads white, misidentifying it as E. dianae var. longibracteatum Fyson.

Additional citations: INDIA: Karnataka: Hooper & Gandhi HFP. 2432 (N). THAILAND: Maxwell 71-563 (Ac), 73-446 (Ac), 74-893 (Ac).

ERIOCAULON AFZELIANUM Wikstr.

Additional bibliography: Moldenke, Phytologia 29: 88. 1974; Hocking, Excerpt. Bot. A.26: 89. 1975.

ERIOCAULON ALPESTRE Hook. f. & Thoms.

Additional bibliography: Moldenke, Phytologia 32: 464. 1975.

Copeland encountered this plant in flower and fruit in October. The Collector undetermined s.n. [Musashi: Tabata, 27 Sept. 1910] and Faurie 891, distributed as E. alpestre, actually represent E. robustius (Maxim.) Mak.

Additional citations: SIKKIM: Hooker s.n. [8—12,000 ped.] (W—2501697). INDIA: Khasi States: Hooker f. & Thomson s.n. [Mont. Khasia 5—6000 ped.] (W—2495292). PHILIPPINE ISLANDS: Mindanao: E. B. Copeland 1431 (W—628555).

ERIOCAULON ALPINUM Van Royen

Additional bibliography: Moldenke, Phytologia 32: 464. 1975.

Recent collectors refer to this plant as a "rosette herb in clumps, leaves glossy medium-green, inflorescence light-brown" and have encountered it in bogs and open grassland of terraced intermontane basins, at altitudes of 2700—3600 meters, flowering and fruiting in June and July.

Additional citations: NEW GUINEA: Papua: Croft & Lelean LAE.41747 (Mu); Croft & al. LAE.61649 (Mu, Mu), LAE.61652 (Mu, Mu).

ERIOCAULON AMBOENSE Schinz

Additional bibliography: Moldenke, Phytologia 29: 88 & 232. 1974.

Giess describes this plant as having leaves to 3 cm. long, peduncles to 6 cm. long, and the flowering-heads black.

Additional citations: NAMIBIA: Giess 9372 (Mu).

ERIOCAULON AQUATICUM (J. Hill) Druce

Additional & emended bibliography: Bolkh., Grif, Matvej., & Zakhar., Chrom. Numb. Flow. Pl., imp. 1, 274 (1969) and imp. 2, 274. 1974; Napp-Zinn, Anat. Blat. 969 & 1157. 1974; Hocking, Excerpt. Bot. A.26: 89 & 90. 1975; Moldenke, Phytologia 32: 464 (1975) and 32: 505. 1976.

Additional citations: GREAT BRITAIN: Scotland: Herb. U. S. Dept. Agr. s.n. [Dumochty Lake, Aug. 8, 1825] (W—45295); Winterbottom s.n. [1838—1842] (Sd—23691). ISLE OF SKYE: Boettcher s.n. [Aug. 8, 1829] (W—1273845). EIRE: Galway: J. Ball s.n. [Sept. 5th, 1837] (W—297369); Linton s.n. [Connemara, 12.viii. 1885] (W—1312420); Lomax s.n. [2 Augusti 1886] (W—1275380); Praeger s.n. [14 July 1899] (W—1275313).

ERIOCAULON ATRATUM Körn.

Additional bibliography: Holm, Bot. Gaz. 31: 18. 1901; Moldenke, Phytologia 32: 464—465. 1975.

Recent collectors have found this plant growing in tussock grassland on mountaintops, on sand-and-gravel bars in rivers, in small areas of marshy grassland in forest openings, and in shallow soil among low trees around the margins of flat rock outcrops with grassy areas, refer to it as cespitose, with white heads,

and found it flowering and fruiting in October.

Additional citations: SRI LANKA: Davidse & Sumithraarachchi 8002 (Ld), 8035 (Ld), 8596 (Ld), 8636 (Ld).

ERIOCAULON ATRATUM var. MAJOR Thwaites

Additional bibliography: Moldenke, Phytologia 29: 86, 91--92, & 205 (1974) and 30: 124. 1975.

Recent collectors have found this plant growing among shrubby and herbaceous vegetation on steep cliffs near the tops of mountain peaks, in cracks of wet cliff faces, and in small open areas of grassland in marshy forest clearings, flowering and fruiting in November. They describe the plants as having more or less extended and curved basal stems and white heads.

Additional citations: SRI LANKA: Davidse & Sumithraarachchi 7952 (Ld), 8000 (Z), 8003 (Ld), 8651 (Ld).

ERIOCAULON ATRUM Nakai

Additional bibliography: Moldenke, Phytologia 29: 92. 1974.

Material of this species has been misidentified and distributed in some herbaria as E. nipponicum Maxim.

Additional citations: JAPAN: Honshu: Collector undetermined s.n. [Imashiro, Ose, 24 August 1911] (W--1310120).

ERIOCAULON AUSTRALE R. Br.

Additional bibliography: Moldenke, Phytologia 32: 465 (1975) and 33: 373. 1976.

Recent collectors refer to this plant as an erect annual herb, the leaf-bases rather fleshy, the scapes to 27 inches tall, with white flower-heads and flowers and have found it growing in marshy ground, along roadsides, in tufts at the edges of mangrove swamps, near swamps and in swampy areas near streams, in ponds and ditches, in and about puddles in roads through savannas, and in inundated soil and culverts in catchment areas, at altitudes of 5--20 m., flowering and fruiting from March to May and July to October. Cushing reports that on Yap it is called "kai", a name also applied there to the orchid, Taeniophyllum, an octopus, and a spider, all of which are characterized by "a sunburst growth pattern". Collectors have also encountered this plant in shallow freshwater at the edges of streams and in open seasonally wet grass-sedge plains with a thin sand cover over clay. Pullen refers to it as a "locally common tussocky herb".

Material has been misidentified and distributed in some herbaria under the names E. longifolium Nees & Kunth, E. sexangulare L., and E. truncatum Mart. On the other hand, the L. A. S. Johnson 17733 and C. Wright 549, distributed as E. australe, are better regarded as E. willdenovianum Moldenke.

Additional citations: NICOBAR ISLANDS: Teressa: Kamphøvener 2478 (W--1080994). CHINA: Kwangtung: C. O. Levine s.n. [Canton Chr. Coll. 833] (W--1091660); Tso 20015 (W--1431973). MALAYA: Perak: Carrick 837 (Kl--3807). Selangor: Kasim bin Rajab 80

(Kl—1080); Poore 95b (Kl—95). Trengganu: Carrick s.n. [3-5-1965] (Kl—3828), A. J. 4003 (Kl—6908); Kasim bin Rajab 5022 (Kl—5022); Soepadmo KLU.9133 (Kl—12929). PALAU ISLANDS: Yap: Cushing 431 (Kl—8353). GREATER SUNDA ISLANDS: Labuan: E. D. Merrill "O" (W—438748). Sarawak: Gaudet M.212 (Kl—6979), M. 231 (Kl—6994). NEW GUINEA: Papua: Pullen 7154 (W—2636066). AUSTRALIA: Northern Territory: Specht 890 (W—2125012). Queensland: M. S. Clemens s.n. [2 April 1945] (Mi).

ERIOCAULON AUSTRALE f. PROLIFERUM Moldenke, Phytologia 33: 373. 1976.

Bibliography: Moldenke, Phytologia 33: 373. 1976.

This form has been encountered at altitudes of 300—400 feet, flowering and fruiting in April.

Citations: MALAYA: Johore: Khatijah & Bastiah KLU.18541 (Kl—18541—type, Z—photo of type). GREATER SUNDA ISLANDS: Sarawak: Carrick & Enoch JC.148 (Kl—3137).

ERIOCAULON BEAUVERDI Moldenke

Emended synonymy: Eriocaulon giganteum Beauverd, Bull. Herb. Boiss., ser. 2, 8: 987. 1909 [not E. giganteum Afzel., 1856, nor Mart., 1975, nor Riedel, 1959].

Additional bibliography: Moldenke, Phytologia 29: 93 (1974) and 33: 26, 189, & 191. 1976

ERIOCAULON BIFISTULOSUM Van Heurck & Muell.-Arg.

Additional bibliography: Moldenke, Phytologia 32: 465 (1975) and 33: 13 & 14. 1976; P. Morat, Adansonia, ser. 2, 15: [463]. 1976.

ERIOCAULON BLUMEI Körn.

Additional bibliography: Moldenke, Phytologia 29: 94 & 206. 1974.

Gaudet found this plant in anthesis in March.

Additional citations: GREATER SUNDA ISLANDS: Sarawak: Gaudet M.255 (Kl—2929).

ERIOCAULON BROWNIANUM var. LATIFOLIUM Moldenke

Additional bibliography: Moldenke, Phytologia 32: 468. 1975.

Recent collectors have found this plant growing in marshy ground along streamlets and on wet rocks of riverbanks in the shade of the forest edge, flowering and fruiting in November and December. They describe the plant as cespitose, with erect stems, the plants growing singly or in clumps of up to 6 plants, the old roots and stems extending backwards up to 30 cm., the leaves holding water like bromeliad leaves, and the flowering heads white.

Additional citations: SRI LANKA: Davidse & Sumithraarachchi 8701 (Ld), 8902 (Ld).

ERIOCAULON BUERGERIANUM Körn.

Additional bibliography: Sonohara, Tamada, & Amano [ed. E. H. Walker], Fl. Okin. 205. 1952; Moldenke, Phytologia 32: 468. 1975.

Ching refers to this plant as a tufted rush-like herb common on the open banks of rice fields. He found it in flower and fruit in October.

Eriocaulon pachypetalum seems to be based on Shimada s.n. [Herb. Taiwan 5558] from Formosa.

The Ching 8939, cited below, bears a striking habital resemblance to E. nudicuspe Maxim., but Ching 8829 is plainly what I regard as typical E. buergerianum.

Material of E. buergerianum has been misidentified and distributed in some herbaria as E. truncatum Hamilt. On the other hand, the Bohnhof 294, Collector undetermined s.n. [Shimura, Oct. 20, 1893], J. Matsumura s.n. [Tokio, October 5, 1879], and Tsang 20687, distributed as E. buergerianum and in some cases even so cited by me in previous publications, are actually E. robustius (Maxim.) Mak., while Walker, Sonohara, Tawada, & Amano 7120 and Walker, Tawada, & Amano 6479 are E. suishaense Hayata. Ching 7814 is a mixture with something in the Cyperaceae.

Sonohara and his associates (1952) report this species from "In wet soil in Kunigami, Nakagami, Ishigati, and Iriomote", but I strongly suspect that the plant referred to is actually E. suishaense; the vernacular names, "oh-hoshikusa" and "pipewort", reported by them, probably also belong to the latter taxon.

Additional citations: CHINA: Anhwei: Ching 8829 (W—1279831), 8939 (W—1279832). Kwangsi: Ching 7814, in part (W—1508962). Yünnan: Delavay s.n. [Tchen-fong-chan 1894] (W—2494893). FORMOSA: Shimada s.n. [Herb. Taiwan 5558] (W—photo).

ERIOCAULON CEYLANICUM Körn.

Additional bibliography: Moldenke, Phytologia 32: 468 (1975) and 32: 488. 1976.

Davidse found this plant in flower in October, growing in compact patches in montane tussock grassland on slopes above a river, the flower-heads white.

Additional citations: SRI LANKA: Davidse 7607 (Z).

ERIOCAULON CINEREUM R. Br.

Additional & emended bibliography: Sonohara, Tawada, & Amano [ed. E. H. Walker], Fl. Okin. 205. 1962; Bolkh., Grif, Matvej., & Zakhar., Chrom. Numb. Flow. Pl., imp. 1, 274 (1969) and imp. 2, 274. 1974; Moldenke, Phytologia 32: 463 & 468—469 (1975) and 32: 503. 1976.

Recent collectors describe this plant as an annual herb, 3—4 inches tall, the leaves 1 to 1 1/2 inches long, light-green, "radiant" [i.e., radiating from the base], flat, the inflorescences erect and white. They have found it in flower in April, June, July, and September and in fruit in July and October (in

addition to the months previously reported), growing at altitudes of 3—2100 meters, and report the vernacular name, "hishi-gusa". Dorsett & Morse refer to it as quite abundant in paddy fields, the flowers "white", while Ching describes the flowers as "whitish" and found the species to be common in Kwangsi. Hatusima refers to it as a common annual in paddy fields on Ishigaki island. Fosberg found it "occasional in drying mud in rice patches between harvest and plowing" on Miyakojima island. Other recent collectors have encountered it in moist rice paddies, at the edges of Melaleuca leucodendron lagoons, in damp areas at the foot of sandstone hills, and at the "edge of freshwater pools in streambed on top of sandstone scarp".

Eriocaulon formosanum Hayata appears to be based on Shimada s. n. [Oct. 8, 1915; Herb. Taiwan 5544] from Formosa, a photograph of which is in the United States National Herbarium in Washington.

Sonohara and his associates (1952) record E. cinereum from "In wet soil in Kunigami, Nakagami, Ishigaki, and Yonaguni" in the Ryukyu Islands and list the vernacular name, "hoshikusa". Philippine material of E. cinereum has been misidentified and distributed in some herbaria as E. merrillii Ruhl.

The Ching 8829 & 8939, distributed as E. cinereum, actually are E. buergerianum Körn., McGregor s.n. [Herb. Philip. Bur. Sci. 19980 & 20172] are E. merrillii Ruhl., M. Ramos s.n. [Herb. Philip. Bur. Sci. 24089] seems to be a mixture with E. merrillii and something non-eriocaulaceous, Clemens & Clemens 3275, C. B. Robinson 1043, and Squires 91 are E. robinsonii Moldenke (of which the second-mentioned is the type collection), Tanaka & Shimada 13574 is E. robustius (Maxim.) Mak., and Reillo s.n. [Herb. Philip. Bur. Sci. 19267] and Toroes 2581, 4572, & 5024 are E. truncatum Hamilt.

Additional citations: AFGHANISTAN: Podlech 16790 (Mu). INDIA: Mysore: G. Thomson s.n. [Maisor & Carnatic] (W—2500545). SRI LANKA: Thwaites C.P.795 (W—2500531). CHINA: Chekiang: Chiao 18882 (W—1554079). Kwangsi: Ching 7263 ["2763"] (W—1508805). CHINESE COASTAL ISLANDS: Honam: C. O. Levine s.n. [Herb. Canton Chr. Coll. 912] (W—1091690). HONG KONG: C. Wright s.n. [Hong Kong] (W—46455). THAILAND: Maxwell 73-457 (Ac). KOREA: Dorsett & Morse 6328 (W—1554391). JAPAN: Honshu: Collector undetermined s.n. [Wada-mura, Musashi, Oct. 30, 1893] (W—205475), s.n. [Musashi: Otaia, 20 Sept. 1911] (W—1310115); Hashimoto 1624 (W—2335115); Itô & Koyama 826 (W—2188463). Miyakojima: F. R. Fosberg 38594 (W—2459575). RYUKYU ISLAND ARCHIPELAGO: Ishigaki: Hatusima 19025 (W—2243622). FORMOSA: Shimada s.n. [Oct. 8, 1915; Herb. Taiwan 5544] (W—photo). PHILIPPINE ISLANDS: Luzon: E. D. Merrill 293 (W—1310073); M. Ramos s.n. [Herb. Philip. Bur. Sci. 24072] (W—1239259); Rogerson 1099 (W—1940735). AUSTRALIA: Northern Territory: Specht 336 (W—2094618), 461 (W—2094712), 1092 (W—2125160). MOUNTED ILLUSTRATIONS: Siddiqui in Fl. W.

Pakist. Pl. ined. (N).

ERIOCAULON COLLINUM Hook. f.

Additional bibliography: Moldenke, Phytologia 32: 469. 1975.

Davidse encountered this plant "in small streamlets down brushy slopes", at 1200 meters altitude, flowering and fruiting in November, and describes the heads as grayish-white.

Additional citations: SRI LANKA: G. Davidse 8481 (Ld).

ERIOCAULON COMPRESSUM Lam.

Additional bibliography: Holm, Bot. Gaz. 31: 33. 1901; Gleason, New Britt. & Br. Illustr. Fl., imp. 1, 1: 373 & 374 (1952), imp. 1, 3: 562 & 568 (1952), imp. 2, 1: 373 & 374 (1958), imp. 2, 3: 562 & 568 (1958), imp. 3, 1: 373 & 374 (1963), and imp. 3, 3: 562 & 568. 1963; G. W. Thomas, Tex. Pl. Ecol. Summ. 32. 1969; Moldenke, Phytologia 32: 469—470. 1975.

Additional illustrations: Gleason, New Britt. & Br. Illustr. Fl., imp. 1, 1: 373 (1952), imp. 2, 1: 373 (1958), and imp. 3, 1: 373. 1963.

D'Arcy refers to the heads of this species as "grayish-white" and found the plant growing in wet ditches.

The Thomas, Dorris, & Drane 13921, distributed as E. compressum, actually is E. decangulare L.

Additional citations: FLORIDA: Gilchrist Co.: D'Arcy 1493 (Sd—86739).

ERIOCAULON DECANGULARE L.

Additional & emended bibliography: Holm, Bot. Gaz. 31: 17—37, fig. 1—5. 1901; Pilger in Engl. & Prantl, Nat. Pflanzenfam. Ergänz. 2, Nachtr. 3 zu 2: 37. 1908; Gleason, New Britt. & Br. Illustr. Fl., imp. 1, 1: 373 (1952), imp. 1, 3: 562 & 568 (1952), imp. 2, 1: 373 (1958), imp. 2, 3: 562 & 568 (1958), imp. 3, 1: 373 (1963), and imp. 3, 3: 562 & 568. 1963; G. W. Thomas, Tex. Pl. Ecolog. Summ. 32. 1969; Beecher, Exxon USA 14 (4): 29. 1975; Moldenke, Phytologia 32: 488—489. 1975.

Additional illustrations: Holm, Bot. Gaz. 31: 21, fig. 1—5. 1901; Gleason, New Britt. & Br. Illustr. Fl., imp. 1, 1: 373 (1952), imp. 2, 1: 373 (1958), and imp. 3: 373. 1963; Beecher, Exxon USA 14 (4): 29 [in color]. 1975.

Stapf (1930) regards "1906" as the date of publication for the Pilger work (1908) cited above, but the United States Library of Congress printed card retains the 1908 title-page date. The Holm (1901) reference, also referred to above, is sometimes misdated "1904".

Thomas (1969) calls this species the "tenangle pipewort". Webster & Wilbur encountered it in savanna areas of longleaf and loblolly pine.

Additional citations: MISSISSIPPI: Covington Co.: Webster & Wilbur 3373 (Mi). Hancock Co.: Gander 7605 (Sd—25492). LOUISIANA: Jackson Par.: Thomas, Dorris, & Drane 13921 (Kl—11795). St. Tammany Par.: C. A. Brown 2568 (Mi).

ERIOCAULON DEPAUPERATUM Merr.

Additional bibliography: Moldenke, Phytologia 29: 113. 1974; Hocking, Excerpt. Bot. A.26: 89. 1975.

Ramos & Edaño found this plant in flower and fruit in September.

Additional citations: PHILIPPINE ISLANDS: Luzon: Ramos & Edaño s.n. [Herb. Philip. Bur. Sci. 40528] (W--1261525).

ERIOCAULON DEPRESSUM R. Br.

Additional bibliography: Hocking, Excerpt. Bot. A.26: 89. 1975; Moldenke, Phytologia 32: 489. 1976.

Specht refers to this species as an annual herb, the flowers white, the fruiting heads light-brown, and found it growing in damp areas at the foot of sandstone hills and at the edge of freshwater pools in streambeds on top of sandstone scarps, flowering in September, fruiting in June.

Additional citations: AUSTRALIA: Northern Territory: Specht 462 (W--2094713), 1091 (W--2125159, Z).

ERIOCAULON DIANAE var. LONGIBRACTEATUM Fyson

Additional bibliography: Moldenke, Phytologia 32: 489. 1976.

The Hooker & Gandhi HFP.2432, distributed as E. dianae var. longibracteatum, actually is E. achiton Körn.

ERIOCAULON DICTYOPHYLLUM f. VIVIPARUM Moldenke

Additional bibliography: Moldenke, Phytologia 29: 194--195. 1974.

The Eitens have encountered this plant with its "base in water at brookside, rooted in brown sand in light shade of narrow gallery scrub" and describe the heads as white.

Additional citations: BRAZIL: Mato Grosso: Eiten & Eiten 8625 (N).

ERIOCAULON DIMORPHOPETALUM Moldenke

Additional bibliography: Moldenke, Phytologia 29: 283. 1974.

Davidse has found this plant growing "submerged in shallow water, except for the inflorescence, in shallow pond with about 1 foot of standing open water in Trachypogon-Curatella savanna", at 40 m. altitude, flowering and fruiting in November.

Additional citations: VENEZUELA: Bolívar: G. Davidse 4400 (Z).

ERIOCAULON DREGEI Hochst.

Additional bibliography: Holm, Bot. Gaz. 31: 18. 1901; Moldenke, Phytologia 29: 195. 1974.

ERIOCAULON ECHINULATUM Mart.

Additional bibliography: Moldenke, Phytologia 32: 490. 1976.

Ramos found this plant in flower and fruit in October.

Additional citations: INDIA: State undetermined: Griffith s. n. [Herb. Van Heurck 579] (W--2595296). CHINA: Kwangtung: Sampson 13453 (W--2495296). THAILAND: Maxwell 71-564 (Ac).

PHILIPPINE ISLANDS: Culion: M. Ramos s.n. [Herb. Philip. Bur. Sci. 41325] (W--1261859).

ERIOCAULON ELICHRYSOIDES Bong.
Additional bibliography: C. Müll. in Just, Bot. Jahresber. 16 (1): 769. 1888; Holm, Bot. Gaz. 31: 19, 30, & 36. 1901; Moldenke, Phytologia 29: 196. 1974.

ERIOCAULON FISTULOSUM R. Br.
Additional bibliography: Moldenke, Phytologia 32: 492. 1976.
Additional citations: AUSTRALIA: Queensland: Banks & Solander s.n. [1770] (W--1276298).

ERIOCAULON HENRYANUM Ruhl.
Additional bibliography: Moldenke, Phytologia 29: 199 (1974) and 33: 373. 1976.
Recent collectors have encountered this plant in swampy ground, bogs, and "swampy holes in rock face", flowering in July. The flowers are said to have been "white" on Rock 24927.
Material of this species has been misidentified and distributed in some herbaria as E. cristatum Mart. and as E. cristatum var. mackii Hook. f.
Additional citations: CHINA: Fukien: J. B. Norton 1187 (W--1050933). Yünnan: A. Henry 9443 (W--457065--isotype); Rock 4587 (W--1512229), 5349 (W--1512254), 5459 (W--1512260), 5882 (W--1718104), 10704 (W--1512322), 24927 (W--1513627). Province undetermined: Delevay s.n. [Tsong so, 28 avril 1890] (W--2495295).

ERIOCAULON HENRYANUM f. VIVIPARUM Moldenke, Phytologia 33: 373--374. 1976.
Bibliography: Moldenke, Phytologia 33: 373--374. 1976.
Citations: CHINA: Fukien: J. B. Norton 1188 (W--1050934--type).

ERIOCAULON HETEROCHITON Körn.
Additional bibliography: Moldenke, Phytologia 29: 199. 1974; P. Morat, Adansonia, ser. 2, 15: [463]. 1976.

ERIOCAULON HETEROGYNUM F. Muell.
Additional bibliography: Moldenke, Phytologia 32: 494. 1976.
Perry describes this species as a small herb, 4 inches tall, with yellow heads, and encountered it in sandy creekbeds, flowering and fruiting in July.
Additional citations: AUSTRALIA: Northern Territory: R. A. Perry 2643 (W--2156548, Z).

ERIOCAULON HONDOENSE Satake
Additional bibliography: Moldenke, Phytologia 29: 200. 1974.
This plant has been collected in fruit in October and the name, "inu-no-hige", is reported for it.
Additional citations: JAPAN: Honshu: Collector undetermined

s.n. [Arai-mura, Musashi, Oct. 22, 1893] (W--205476), s.n. [Shimousa: Nakayama, 26 Sept. 1910] (W--1310119); Hashimoto 399 (W--2242168); Ohwi & Koyama 1124 (W--2211650); Togasi 722 (W--2156649), 914 (W--2188534), 1101 (W--2211632); Togashi MT.6849 [Fl. Jap. Exsicc. 67] (Mu). Shikoku: Collector undetermined s.n. [Sakawa, Tosa, Sept. 20, 1894] (W--248163).

ERIOCAULON HOOKERIANUM Stapf

Additional bibliography: Moldenke, Phytologia 32: 495. 1976.

Croft and his associates describe this plant as a rosette herb with semi-glossy midgreen leaves and white inflorescences and have found it in swampy grasslands at 2000 meters altitude, in flower and fruit in July.

The H. H. Bartlett 7457, distributed as E. hookerianum, appears to be E. infirmum var. puberulentum (Moldenke) Van Royen, not E. merrillii Ruhl. as previously reported by me.

Additional citations: GREATER SUNDA ISLANDS: Sabah: Topping 1885 (W--1376760), 1887 (W--1376762). Sumatra: H. H. Bartlett 7883 (W--1552471). NEW GUINEA: Papua: Croft & al. LAE.61929 (Mu).

ERIOCAULON HUIANUM Ruhl.

Additional bibliography: Moldenke, Phytologia 26: 26. 1973.

Additional citations: CHINA: Kiangsi: Lau 4229 (W--1752934).

ERIOCAULON HUMBOLDTII Kunth

Additional bibliography: Moldenke, Phytologia 32: 495. 1976.

Pursell and his associates found this plant growing in standing water, while Goodland encountered it in grassland with scattered trees, Curatella, Byrsonima, Trachypogon, and Fimbristylis dominant. Schulz found it "frecuente en el borde de un 'morichal' (con Mauritia flexuosa en la parte central), sitio inundado (5--15 cm de agua), pero con ausencia de agua superficial en la época seca, suelo rico en mat. orgán., subsuelo grava arena, vegetac. dominada por Cyperac. No. 622, Gram./Cyp. 626-627-628, Xyris savan., estrata arbustiva original de Jussiaea lithospermifolia eliminada por quema anual y pastoreo." Davidse & Llanos found it growing "in marshy area around lake margins dominated by scattered sedges and Mauritia flexuosa palms", but make the curious statement "plants with stilt roots" — a character never before reported. They state that the heads are white.

Additional citations: COLOMBIA: Vichada: Davidse & Llanos 5228 (Ld). VENEZUELA: Guárico: J. P. Schulz 623 (Ut--320384). Monagas: Pursell, Curry, & Kremer 8310 (W--2546258). GUYANA: Goodland 888 (W--2548126).

ERIOCAULON INFIRMUM var. PUBERULENTUM (Moldenke) Van Royen

Additional bibliography: Moldenke, Phytologia 32: 496. 1976.

Recent collectors describe the inflorescence-heads of this plant as "bluish-white" and have found it growing on a high

plateau, flowering and fruiting in April and October. Material has been misidentified and distributed in some herbaria as E. hookerianum Stapf, E. merrillii Ruhl., and E. truncatum Hamilt.

Additional citations: PHILIPPINE ISLANDS: Culion: M. Ramos s.n. [Herb. Philip. Bur. Sci. 41340] (W—1261867).

ERIOCAULON KÖRNICKIANUM Van Heurck & Muell.-Arg.

Additional bibliography: G. W. Thomas, Tex. Pl. Ecolog. Summ. 32. 1969; Moldenke, Phytologia 32: 497 (1976) and 33: 21. 1976.

Thomas (1969) calls this species the "smallhead pipewort".

ERIOCAULON LATIFOLIUM J. E. Sm.

Additional bibliography: Moldenke, Phytologia 32: 488 & 497 (1976) and 33: 26, 153, & 183. 1976.

Additional citations: LIBERIA: J. T. Baldwin 10382 (W—2070152), 10946 (W—2070175).

ERIOCAULON LIGULATUM (Vell.) L. B. Sm.

Additional bibliography: Holm, Bot. Gaz. 31: 18. 1901; Moldenke, Phytologia 32: 497. 1976.

Lindeman and his associates describe this species as a "locally abundant herb, grayish, the leaf rosette on an up to 30 cm. long stem clothed by old sheaths, the heads white, the involucre yellowish, the bracts with white hyaline margins, the "calyx" [involucre?] dark-green, the florets white, and the anthers dark" or black. They encountered it on yellow-brown clay soil of campos, along creeklets on campos, and in "banhado em Sphagnum", flowering and fruiting in July. It is depicted on their "slide L.11.10,11".

Additional citations: BRAZIL: Paraná: Hatschbach 37922 (Ld); Lindeman & Haas 2419 (Ld), 5670 (Ut—320405). Rio Grande do Sul: Lindeman & Irgang ICN.8116 (Ut—320397). Santa Catarina: Smith & Klein 15591a (W—2653317).

ERIOCAULON LINEARE Small

Additional bibliography: Hocking, Excerpt. Bot. A.26: 89. 1975; Moldenke, Phytologia 32: 498. 1976.

ERIOCAULON LINEARE var. GIGAS Moldenke

Additional bibliography: Moldenke, Phytologia 29: 204. 1974; Hocking, Excerpt. Bot. A.26: 89. 1975.

ERIOCAULON LIVIDUM F. Muell.

Additional bibliography: Moldenke, Phytologia 29: 204—205. 1974.

Latz refers to thus plant as an "erect ephemeral, heads white, rare in damp clayey loam in mixed grassland fringing lagoon" and found it in flower and fruit in May. It has also been misidentified and distributed in some herbaria as "E. quinquangulare L. sens. lat., also close to E. schultzii" Benth.

Additional citations: AUSTRALIA: Northern Territory: Latz 3703 (Z).

ERIOCAULON MAGNIFICUM Ruhl.

Additional bibliography: Moldenke, Phytologia 29: 206. 1974.

Rambo (1950) comments that "Até o momento só o conheço de Sombrio; sua constatação ao sul de Torres é questão de ulteriores pesquisas. Seja dito de passagem, que após comparação minuciosa do material com E. megapotamicum, não estou convencido duma verdadeira diferença entre as duas espécies". He is certainly correct in saying that the two taxa are extremely similar.

Additional citations: BRAZIL: Rio Grande do Sul: J. Vidal IV. 288 [Herb. Mus. Nac. Rio Jan. 105086] (W—2653329).

ERIOCAULON MAGNUM Abbiatti

Additional bibliography: Moldenke, Phytologia 32: 498. 1976.

Recent collectors have found this plant in fruit in November.

Additional citations: ARGENTINA: Corrientes: Achinini & Carnevali 10313 (Ld).

ERIOCAULON MEGAPOTAMICUM Malme

Additional bibliography: Moldenke, Phytologia 29: 207. 1974.

Rambo (1950) comments that "O lugar típico desda espêcie é Povo Novo perto de Pelotas; entretanto, é o Eriocaulon predominante dos arredores de Osório, onde cresce de mistura com o Syngonanthus acima mencionado". He also affirms that he is unable to differentiate this species from E. magnificum Ruhl.

ERIOCAULON MELANOCEPHALUM Kunth

Additional bibliography: Moldenke, Phytologia 32: 499. 1976; P. Morat, Adansonia, ser. 2, 15: [463]. 1976.

Bunting and his associates describe this plant as an aquatic herb with the flower-heads above the water, the floral bracts dark, and the flowers whitish. Hatschbach & Kummrow report finding it in "lake water", flowering and fruiting in March.

Additional citations: VENEZUELA: Amazonas: Bunting, Akkermans, & Van Rooden 3457 (Ut—320386). BRAZIL: Goiás: Hatschbach & Kummrow 38331 (Ld).

ERIOCAULON MERRILLII Ruhl.

Additional bibliography: Moldenke, Phytologia 26: 461. 1973.

The E. sollyanum var. sumatranum Van Royen, previously regarded by me as a synonym of E. merrillii, seems, rather, to be a distinct, albeit very closely related, taxon.

Recent collectors have found E. merrillii in flower and fruit in September and October. Material has been misidentified and distributed in some herbaria as E. cinereum R. Br. and as E. nigriceps Merr. The M. Ramos s.n. [Herb. Philip. Bur. Sci. 24089] collection, cited below, is a mixture with something noneriocaulaceous and may also include some E. cinereum material. The H. H. Bartlett 7457 and Boeea 5963, 6008, 8764, & 10343, distributed and previously cited by me as E. merrillii, apparently are E. sollyanum var. sumatranum Van Royen instead.

Additional citations: PHILIPPINE ISLANDS: Luzon: Elmer 14350 (W--1050497); E. D. Merrill 3624 (W--438487); M. Ramos s.n. [Herb. Philip. Bur. Sci. 24089, in part] (W--1239271); R. S. Williams 946 (W--707273), 1004 (W--707312). Polillo: C. B. Robinson s.n. [Herb. Philip. Bur. Sci. 9031] (W--629562). Sibuyan: Elmer 12248 (W--872870).

ERIOCAULON MIQUELIANUM Körn.
Additional bibliography: Moldenke, Phytologia 29: 209. 1974.
Togashi reports encountering this plant in "wet fields near rice fields".
The Collector undetermined s.n. [Sakawa, Tosa, Sept. 20, 1894], s.n. [Arai-mura, Musashi, Oct. 22, 1893], and s.n. [Shimousa: Nakayama, 26 Sept. 1910], distributed as E. miquelianum, are actually E. hondoense Sataka, while Collector undetermined 494 is E. nipponicum Maxim.
Additional citations: JAPAN: Honshu: Togashi MT.6857 [Fl. Jap. Exsicc. 68] (Mu).

ERIOCAULON MIQUELIANUM var. LUTCHUENSE (Koidz.) T. Koyama
Additional bibliography: Sonohara, Tawada, & Amano [ed. E. H. Walker], Fl. Okin. 205. 1952; Moldenke, Phytologia 24: 478. 1972.
Sonohara and his associates (1952) record this plant from "In wet soil in Kunigami, Nakagami, Kume, and Ishigaki" in the Ryukyu Islands, as well as Okinawa, and record the vernacular name, "Okinawa-hoshikusa".

ERIOCAULON MODESTUM Kunth
Additional bibliography: Moldenke, Phytologia 32: 501. 1976.
Rambo (1950) comments that "Citada por FB para a Ilha de Sta. Catarina, foi constatada em Mostardas por um exemplar da Herbário Anchieta, para os arredores da cidade do Rio Grande por Malme, e para o Uruguai por Herter; no litoral norte ainda não a encontrei." Lindeman encountered the species in a "pequeñ lagoa atras das dunas primarias.....na margem em humus úmido", flowering and fruiting in November.
Additional citations: BRAZIL: Rio Grande do Sul: Lindeman ICN. 20908 (Ut--320392); J. Vidal IV.174 [Herb. Mus. Nac. Rio Jan. 105083] (W--2653327), s.n. [Herb. Mus. Nac. Rio Jan. 126570] (W--2653328).

ERIOCAULON MOKALENSE Moldenke
Additional bibliography: Moldenke, Phytologia 24: 480. 1972; P. Morat, Adansonia, ser. 2, 15: [463]. 1976.

ERIOCAULON MONTANUM Van Royen
Additional bibliography: Moldenke, Phytologia 32: 502. 1976.
Croft and his associates describe this species as an "herb forming compact cushions" or "rosettes forming large cushions", the leaves dull medium-green or "semi-glossy mid-green", and the

inflorescence pale-green, the flowers medium green, and have encountered it in subalpine grassland or along the banks of streams in intermontane grassland basins, at 2800—3300 m. altitude, flowering and fruiting in July.

Additional citations: NEW GUINEA: Papua: Croft & al. LAE.61489 (Mu, Z), LAE.65250 (Mu).

ERIOCAULON MUTATUM N. E. Br.

Additional bibliography: Moldenke, Phytologia 29: 210. 1974; P. Morat, Adansonia, ser. 2, 15: [463]. 1976.

ERIOCAULON NANTOENSE Hayata

Additional bibliography: Moldenke, Phytologia 29: 210. 1974.

Additional citations: FORMOSA: Kawakami s.n. [Herb. Taiwan 5553] (W—photo of isotype).

ERIOCAULON NEO-CALEDONICUM Schlecht.

Additional bibliography: Moldenke, Phytologia 24: 483. 1972.

Additional citations: NEW CALEDONIAN ISLANDS: New Caledonia: Franc A.266, in part (W—1370830—cotype); McKee 3383 (W—2210249).

ERIOCAULON NEPALENSE Prescott

Additional bibliography: Moldenke, Phytologia 32: 502. 1976.

Nicolson refers to this plant as "occasional" in wet swampy areas or wet places in general, at 1500—1800 m. altitude, and collected it in flower in September. Inexplicably, he describes the flowers as "blue" on his no. 2361 — perhaps through an error in transcription.

Additional citations: NEPAL: Nicolson 2264 (W—2571147), 2361 (W—2571148).

ERIOCAULON NIGERICUM Meikle

Additional bibliography: Moldenke, Phytologia 26: 461. 1973.

The United States National Herbarium sheet of Baldwin 9145 includes a photographic copy of the original illustration of this species as published by Meikle & Baldwin (1952).

Additional citations: LIBERIA: J. T. Baldwin 9145 (W—2070083, Z), 9456 (W—2070100), 10088 (W—2070123), 10336 (W—2070145).

ERIOCAULON NIGRUM H. Lecomte

Additional bibliography: Moldenke, Phytologia 26: 31. 1973.

Additional citations: INDOCHINA: Tonkin: Pételot 113bis (W—1597267, Z).

ERIOCAULON NILAGIRENSE Steud.

Additional bibliography: Moldenke, Phytologia 32: 502—503. 1976.

Sohmer and his associates encountered this plant as common "in water of small stream" and describe the flower-heads as "grayish-colored", in anthesis in November. Stone refers to the plant as "a large species often embedded in dense mats of a small

Panicum sp., occasionally in small open pools in very moist grass-obscured rivulets in patanas in open patches of disturbed ericaceous forest". He describes the flowers as "grayish-white" and found the plant in anthesis in April. Other recent collectors refer to it as "fairly common marshy herbs with prominent heads, peduncles to 50 cm., in partial shade of wet deciduous regions", along trails in montane forests, and at the edges of streams in open marshy grassy areas, the stems and leaves erect, dark-green, and the heads white.

Additional citations: INDIA: Karnataka: Jarrett & Ramamoorthy HFP.995 (N). SRI LANKA: Davidse & Sumithraarachchi 7993 (Ld), 8624 (Ld); Sohmer, Jayasuriya, & Eliezer 8542 (Lc, N); B. C. Stone 11278 (Kl—18852).

ERIOCAULON NILAGIRENSE f. PARVIFOLIUM Moldenke

Additional bibliography: Moldenke, Phytologia 32: 502—503. 1976.

Davidse refers to this plant as cespitose, with white flower-heads, and found it growing in marshy montane tussock grassland along streamlets, flowering and fruiting in October.

Additional citations: SRI LANKA: G. Davidse 7604 (Ld).

ERIOCAULON NIPPONICUM Maxim.

Additional bibliography: Moldenke, Phytologia 29: 212. 1974.

Recent collectors refer to this plant as an annual herb, 10—20 cm. tall, have found it growing in grassy fields and in "water in neglected paddies", at altitudes of 1000—3000 feet as well as at sealevel, flowering and fruiting from July to October, and report the vernacular names, "shiro-inunohige" and "shiro-inu-no-hige".

Material of this taxon has been misidentified and distributed in some herbaria as E. miquelianum Körn. On the other hand, the Collector undetermined s.n. [Imashiro, Ose, 24 August 1911], distributed as E. nipponicum, actually is E. atrum Nakai

Additional citations: CHINA: Fukien: J. B. Norton 1185 (W—1347913). KOREA: D. E. Davis 15 (W—2128326). JAPAN: Honshu: Collector undetermined 494 (W—45280), s.n. [Wada-mura, Musashi, Sept. 6, 1893] (W—205474), s.n. [Musashi: Shinako, 17 Sept. 1910] (W—1310116); E. Elliott 128 (W—1942957); Ohwi & Koyama 137 (W—2037348).

ERIOCAULON NUDICUSPE Maxim.

Additional bibliography: Moldenke, Phytologia 26: 32. 1973.

Additional citations: JAPAN: Honshu: Inami 956 (W—2188573).

ERIOCAULON NUTANS F. Muell.

This taxon should be deleted from the list of accepted taxa. The name is obviously a misspelling of "Eriocaulon natans F. Muell.", a synonym of E. setaceum L.

BOOK REVIEWS

Alma L. Moldenke

"ORCHIDACEARUM ICONUM INDEX" by C. Schuster, iv & 611 pp., Facsimile Edition by Otto Koeltz Science Publishers, D-624 Koenigstein/Taunus, West Germany. 1974. DM.220.

This reprint -- like so much of the careful work of this Koeltz-Antiquariat printing house — is neatly reproduced on good thin paper and securely bound. These treasured Schuster studies were first published serially from 1931 to 1936 as the first seven numbers and in 1943 as the combined last two numbers of Feddes Repertorium Volume 60.

Well over a thousand, all the then-known orchid taxa, are accurately listed with their authorities and published sources of one or more illustrations, for example:

p. 1. "Aa Rchb. f. (Altensteinia H.B.K.)
Aa brevis Schltr. Rep. Beih. lvii (1929) Taf. 105. Nr. 410" and 16 other species split from the century older genus which is herein left with only

p. 11. "Altensteinia fimbriata H.B.K.
H.B.K.: Nov. Gen. 1. (1815) t. 72"
and 2 other species.

p. 311. "X-Laelio-Cattleya Fanny Leon Hort.
(C. labiata x L.-C. exoniensis) Watso et Chapmann: Orchids (1903) p. 285, Farbtaf. — Garden lvii (1900) p. 95, fig." and hundreds of other combinations.

p. 611. "Zygostates lunata Ldl.
Martius: Flor. Bras. iii, 6 (1904—06) t. 45. — Hoehne: Alb. Orch. Bras. Sao Paulo (1930) p. 121, fig."

For a wide range of taxonomists, orchid specialists, orchid breeders and raisers, both serious amateur and professional, this essential study has been more "wanted" than "available" for many years because of the limiting effects of World War 2. Even now promptness in acquisition is urged because only 300 reprint copies were printed.

"DIE LAUBMOOSE FENNOSKANDIAS" by V. F. Botherus, iv & 635 pp., illus., Facsimile Edition by Otto Koeltz Science Publishers, D-624 Koenigstein/Taunus, West Germany. 1974. DM.198.

This is another important taxonomic "classic" to be welcomed by university and herbarium scientists and students interested in mosses — Scandinavian, circumboreal, high altitude, cold weather and/or glacially affected plants. It is a reprint of the 1923 issue of the Flora Fennica I sponsored by the Societas Pro Fauna et Flora Fennica.

For 826 species and a sizable additional number of subspecific units much concisely and accurately presented information is given. The 118 illustrations consist of very finely executed black/white prints of many-parted drawings that confirm, amplify and/or explain the German language text.

"BIOLOGY DATA BOOK" Second Edition, Volume II compiled and edited by Philip L. Altman & Dorothy S. Dittmer for the Federation of American Societies for Experimental Biology, xix & 825 pp., illus., Bethesda, Maryland 20014. 1973. $40.00 or $100.00 for the 3-volume set.

This whole second edition reflects expectedly and well the basic changes during the past decade in biology by being broader in scope because of the continuing growth of interscience disciplines and expanded with carefully verified new material arranged in space, word, energy and time-saving table or graph formats. Volume II contains 96 tables and graphs checked by 260 outstanding named authorities covering: VI. Biological Regulators and Toxins on continuous pagination from Volume I (pp. 607--780), VII. Environment and Survival (pp. 781--1052), VIII. Parasitism (pp. 1053--1126), IX. Sensory and Neuro-Biology (pp. 1127--1308), Appendices listing scientific names and corresponding common names (et v.v.) of plants and animals (pp. 1309--1346), and a detailed index (pp. 1347--1432). Might the appendices and index be joined since many names are already duplicated in them?

What a wonderful service these contributors, compilers and reviewers have provided in this publication of such great value to so many students and scientists of many disciplines!

"THE WEB OF ADAPTATION: Bird Studies in the American Tropics" by David W. Snow, xiii & 176 pp., illus., Demeter Press Book, Quadrangle/New York Times Book Co., New York, N. Y. 10022. 1976. $8.95.

Dr. Snow, now head of the ornithology section of the British Mudeum, together with his wife, here relates some of his fascinating, logical conclusions from the ample field experiences in many parts of the American tropically forested areas, especially in regard to the fruit-eating birds that are not seed destroyers — bellbirds, cock-of-the-rock, mannikins, cotingas, calfbirds and the insect-to fruit- diet switching oilbirds who show concomitant breeding adaptation.

This wonderful natural history book has much to offer to those in the 6-to-96-year age span.

PHYTOLOGIA

Designed to expedite botanical publication

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ERIOGONUM (POLYGONACEAE)
OF
ARIZONA AND NEW MEXICO

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With the increased interest in endangered and threatened plants in the United States, the need for modern keys and descriptions of critical genera is becoming more apparent. There is a growing concern among government officials, both federal and state, that their field workers, even when trained in botany, will not have adequate floras to review and ascertain the biology of the plants considered as endangered or threatened, and to determine the relationships between those plants which are common and those which are rare. The need now for a national flora of the United States is greater than at any time in the history of the nation, but the prospect of a set of manuals which will be of use to the forester, the range manager, and the farmer seems more remote than ever.

The present review of the genus *Eriogonum* (Polygonaceae) is done at the request of the United States Forest Service and the Bureau of Land Management. These two federal agencies are taking an active role in the management of their lands to insure the continued existence of the several species of vascular plants now thought to be endangered or threatened. Although there are a number of species of *Eriogonum* which fall into these categories, the genus is only one of many such genera which investigators should prepare modern treatments for in order to aid these federal agencies in their work. With no treatment of the flora of the southwestern United States available at present which gives both keys and descriptions, such random treatments will be all field workers can hope for.

ERIOGONUM Michx. Wild Buckwheat

Annual or perennial herbs and shrubs with basal or cauline, alternate leaves and often with alternate or whorled scalelike to foliaceous bracts, entire and estipitate; flowers perfect or im-

perfect, borne in campanulate to turbinate or cylindric involucres, 4--10-lobed or toothed, awnless, few- to many-flowered, sessile or peduncled; tepals petaloid, 6-parted in two series of 3 segments each, on a distinct pedicel or the base of the flower attenuated into a stipelike base; stamens 9, the filaments filiform, often pilose basally; ovary 1-celled, styles 3 with capitate stigmas; achenes mostly 3-angled or winged. A North American genus of some 250 species found mainly in the western United States. (Greek, *erion*, wool, and *gonu*, knee or joint, the type of the genus, *E. tomentosum* Michx., being hairy at the nodes.)

KEY TO ERIOGONUM IN ARIZONA

A. Flowers with stipelike bases, mostly yellow to reddish-yellow, glabrous or pubescent; low spreading cespitose to subshrubby perennials.
  B. Flowers glabrous; widespread and common across the northern tier of counties . . . . 28. *E. umbellatum*
  BB. Flowers pubescent without.
    C. Involucres with long, reflexed lobes; flowering stems scapose and ebracted, with a large single terminal involucres; extreme northern Mohave Co. . . . . 29. *E. caespitosum*
    CC. Involucres with shallow erect teeth; flowering stems bracted, terminated by an open, often branched inflorescence, or if capitate, then plants of the Kaibab Plateau; widespread . . . . 30. *E. jamesii*
AA. Flowers not attenuated into a stipelike base.
  B. Plants perennials (see also *E. inflatum*).
    C. Plants cespitose to large shrubs; stems and branches glabrous to tomentose, not strigose; achenes not winged or plump, usually enclosed by the mature flower, brown to black.
      D. Plants distinct shrubs or subshrubs, woody above the spreading caudex and not dying back completely to the ground after each year.
        E. Flowers pubescent without, 2.5—3.5 mm long, white to pink; low shrubs; common throughout most of the state . . . 12. *E. fasciculatum*
        EE. Flowers glabrous without.
          F. Stems smooth, glabrous to tomentose, not angled or ribbed, nor scabrellous.
            G. Inflorescences small and compact, cymose, with involucres dichotomously arranged even at the tips of the branches; stems usually tomentose, occasionally floccose or glabrous.
              H. Leaves revolute, narrow.
                I. Leaves 2—6 cm long.
                  J. Inflorescences open and and spreading, 1.5—6 cm

long, white-tomentose or lanate to (rarely) glabrate and green; leaves 0.3—4 cm long, mostly rigid; rather common in the northern half of the state 1. *E. microthecum*

JJ. Inflorescences densely cymose, 2—15 cm long, glabrous and bright green; leaves 1.5—6 cm long, mostly flaccid; infrequent and local in Apache and Navajo cos. . . . . 4. *E. leptophyllum*

II. Leaves 0.5—2 cm long.

J. Plants subshrubs to low shrubs, not matted; leaves 2—4 mm wide; involucres 2—2.5 mm long . . . . 1. *E. microthecum*

JJ. Plants matted, less than 1 dm high.

K. Flowers 3.5—4.5 mm long; involucres atop of bractless stems; leaves 2—6 mm long, 0.5—1 mm wide; local and rare, southwestern Coconino Co. and northern Yavapai Co. . . . 2. *E. ripleyi*

KK. Flowers 2—2.5 mm long; involucres subtended by bracts; leaves 5—8 mm long, 0.8—2 mm wide; western Mohave Co. east to Navajo Co. and south to Yavapai Co. . . . . 3. *E. ericifolium*

HH. Leaves flat, not revolute.

I. Leaves sharply acute, the blades mostly narrowly elliptic, 1—8 mm wide; plants mostly low subshrubs with floccose stems and of Mohave and Coconino cos., or erect shrubs with glabrate and green stems of Navajo and Apache cos. . . . 1. *E. microthecum*

II. Leaves acute to obtuse or rounded apically, more than 8 mm wide, or if 2—5 mm wide, then margin crenulate and branches of the inflorescence zig-zag.

J. Inflorescences cymose and ± open, not zig-zag.

K. Leaf-blades oblanceolate to elliptic or nearly orbicular, 1—5 cm long, the base cuneate, not cordate or truncate; stems and branches mostly white to grayish tomentose, or infrequently glutinose and green; common from eastern Mohave Co. to Apache Co. . . 6. *E. corymbosum*

KK. Leaf-blades cordate, 1.5—2.5 cm long, the base cordate to truncate; stems and branches brownish-white; local and rather common from east-central Mohave Co. to extreme western Navajo Co. . . . . 8. *E. jonesii*

JJ. Inflorescences of compact masses of zig-zag branches; leaves oblong-lanceolate to oblanceolate, 6—15 mm long, 2—5 mm wide, crenulate; western Mohave Co. . 15. *E. plumatella*

GG. Inflorescences large with numerous branches and branchlets bearing racemosely arranged involucres along their tips; stems and branches glabrous to floccose or infrequently tomentose.

H. Inflorescences open, branches not zig-zag.

I. Leaves 1—4.5 cm long, 2—15 mm wide; inflorescences with involucres racemosely arranged only at the tips of the branches; plants large shrubs 3—13 dm high, up to 20 dm

across; sandy places in northern Arizona.

J. Leaves tomentose at least below.

K. Leaves linear-lanceolate to oblanceolate or narrowly elliptic, 1.5—4.5 cm long, 2—8 mm wide; branches floccose to glabrous; Coconino Co. eastward . . . 9. *E. leptocladon*

KK. Leaves oblanceolate to elliptic, 1—2.5 (3) cm long, 5—15 mm wide; branches tomentose; Coconino Co. westward . . 10. *E. kearneyi*

JJ. Leaves glabrous on both surfaces; plants glabrous throughout; rare and local in extreme eastern Mohave Co. west of Fredonia . . . . 11. *E. mortonianum*

II. Leaves 0.5—1.5 cm long, 2—5 (7) mm wide; inflorescences with long branches essentially with racemosely arranged involucres throughout; plants low subshrubs 1.5—4 dm high, 1—5 dm across, or if up to 7 dm high and 10 dm across, then plants of southern Arizona; common and widespread throughout the state . . . . 22. *E. wrightii*

HH. Inflorescences long with compactly arranged zig-zag clusters of branches, tomentose or glabrous; leaves oblong-lanceolate to oblanceolate, 6—15 mm long, 2—5 mm wide, crenulate; western Mohave Co. . . . . 15. *E. plumatella*

FF. Stems angled and ribbed or scabrellous, not smooth.

G. Involucres campanulate, (0.7) 1—1.5 mm long, 1—2 mm wide; flowers 1.5—2 mm long; low subshrubs up to 6 dm high; stems and branches ribbed and angled or scabrellous; plants of north-western Arizona . . . 13. *E. heermannii*

GG. Involucres turbinate, 0.8--1.5 mm long, 0.7--1.3 mm wide; flowers (2.5) 3--4 mm long; erect, usually much-branched shrubs to 5 dm high; stems and branches scabrellous; southeastern Arizona . . . 14. *E. apachense*

DD. Plants herbaceous, cespitose or pulvinate perennials.

E. Plants herbaceous; inflorescences open.

F. Involucres not arranged racemosely along elongated branches.

G. Flowers glabrous without.

H. Leaves linear to oblong or elliptic, 0.6--5 cm long, 2--15 mm wide, densely tomentose below; involucres sessile, not pedunculate; flowers smooth, not broadly expanded basally; Mohave and Coconino cos.

I. Flowers 2--2.5 mm long; inflorescences with zig-zag branches, tomentose or if glabrous then grayish; involucres 2--2.5 mm long; leaves oblanceolate to oblong-lanceolate, 6--15 mm long, 2--4 mm wide; infrequent, western Mohave Co. . . . 15. *E. plumatella*

II. Flowers 3--3.5 mm long; inflorescences open, cymose, glabrous and green; involucres 2--3.5 mm long; leaves linear to oblanceolate or oblong to elliptic, (2) 3--5 cm long, (3) 4--15 mm wide; local and rare, northeastern Mohave Co. and to be expected in northwestern Coconino Co. . . . . 16. *E. thompsonae*

HH. Leaves ovate to rounded, 0.5--2 cm long and wide, densely white-pilose on both surfaces; involucres 1.5--2 mm long, on peduncles 0.5--2.5 cm long; flowers with broadly expanded bases; local and rare in widely scattered locations in the northwestern and eastern part of Arizona . . . . 33. *E. arizonicum*

GG. Flowers pubescent without.

H. Flowers densely pubescent without

with long white hairs, 2.5--5 (6) mm long; involucres campanulate, 3--6 mm wide; inflorescences subcapitate or rarely cymose; rare and local in central Apache Co. . . . . 20. *E. lachnogynum*

HH. Flowers sparsely to densely pubescent with thin, strigose hairs, usually yellowish or reddish but never white; inflorescences open and much divided.

I. Stems and branches strigose, slender; achenes plump, winged at the apex; local, White Mts., Apache Co. . . . . 31. *E. hieracifolium*

II. Stems and branches glabrous or merely sparsely hirsute near the base, often inflated; achenes slender, the apex merely 3-angled; common and widespread throughout most of the state . . . 34. *E. inflatum*

FF. Involucres racemosely arranged along elongated branches.

G. Plants suffrutescent, low and spreading with numerous branches and stems from the base; involucres 1--2.5 mm long; flowers white, 1.5--3.5 mm long; leaves small, 0.5--1.5 cm long, 2--5 (7) mm wide; widespread and common in Arizona . . . . . . 22. *E. wrightii*

GG. Plants strictly herbaceous, upright and erect with one to few erect branches from the base; involucres 1.5--5 mm long; flowers white to scarlet-red, 2--5 mm long; leaves large, 1.5--10 cm long, 1--3.5 cm wide; local and restricted to the mountains of northern Arizona.

H. Stems and branches tomentose to floccose; common . . . . 23. *E. racemosum*

HH. Stems and branches glabrous; rare and local; both rims of the Grand Canyon . . . . . 24. *E. zionis*

EE. Plants cespitose or pulvinate; inflorescences capitate.

F. Flowers pilose without; achenes and ovaries pubescent; scapose branches up to 3 cm long; eastern Mohave Co. eastward . .

. . . . 25. *E. shockleyi*

FF. Flowers glabrous; achenes and ovaries glabrous; scapose branches up to 15 cm long; northern Arizona . . . . 26. *E. ovalifolium*

CC. Plants erect perennial herbs with elongated, strigose stems and branches; achenes winged and plump, exceeding the flowers at least half their length, greenish to yellowish or light brown.

D. Flowers yellow, strigose without; achenes plump and winged only at the apex; plants not monocarpic; White Mts., Apache and Navajo cos. . . . . 31. *E. hieracifolium*

DD. Flowers yellowish-green, glabrous without; achenes plump and winged the entire length of the fruit; plants monocarphic; widespread in northern and eastern Arizona . . . . 32. *E. alatum*

BB. Plants annual, or if perennial, the flowers yellow and hirsute on long, slender peduncles, and the stems and branches often inflated.

C. Involucres smooth, not ribbed or angled, usually distinctly peduncled, or if sessile, then not vertically appressed to the stems; annuals or perennials.

D. Leaves glabrous, pilose, hispid, or villous on one or both surfaces.

E. Flowers pubescent without with pilose to hirsute hairs, yellow or rarely white to pink.

F. Flowers hirsute without with long, appressed white hairs, bright yellow; stems and branches glabrous or sparsely hirsute at the base and infrequently at the lower nodes.

G. Involucres 5-toothed; plants annual or perennial with open inflorescences, the lower nodes with 3--5 branchlets; flowers 1--3 mm long; stems often inflated; common and widespread throughout most of the state . . . . 34. *E. inflatum*

GG. Involucres 4-toothed; plants strictly annual with whorls of branches (often 5--20) radiating from the lower nodes; flowers mostly 1--2 mm long; stems usually not inflated; widespread and common in all but the northeastern part of the state . 35. *E. trichopes*

FF. Flowers sparsely pubescent without with scattered minute hairs, white to pink or pale yellow; stems and branches glandular at the nodes or villous at the base and lower nodes.

G. Plants glabrous but sparsely glandular at the upper nodes, rounded and compact with hemispherical crowns; leaves spathulate, hirsute; involucres 0.5--0.9 mm long; flowers red to pink, 0.5--0.9 mm long; rare and local, Yavapai Co. . . . . 37. *E. parishii*

GG. Plants glabrous but sparsely floccose at the lower nodes, open and spreading; leaves oblong-oblanceolate to obovate, floccose; involucres 1--1.8 mm long; flowers pale yellow, 1--2.5 mm long; rare and perhaps extirpated from the state, to be expected in sandy soil near old Fort Mohave, Mohave Co. . . . . 38. *E. ordii*

EE. Flowers glabrous without.

F. Flowers 1--2.5 mm long, the tepals mostly oblong, not pandurate; achenes 2--2.5 mm long; involucres 0.6--1.3 mm long; rare, Apache Co. . . . . . . 40. *E. gordonii*

FF. Flowers 0.8--1.6 mm long, the tepals pandurate with the lower lobes auriculate and ± swollen; achenes 1.3--1.6 mm long; involucres 1--1.5 mm long; Gila and Graham cos. . . . . 41. *E. capillare*

DD. Leaves tomentose to lanate below, infrequently white-pilose.

E. Leaves strictly basal or sheathing up the lower stems, not at the lower nodes.

F. Involucres 1--3 mm long, or if shorter, then flowers with saccate-dilated bases on the outer tepals.

G. Flowers glabrous without.

H. Leaves white-pilose on both surfaces, ovate to rounded, 0.5--2 cm long and wide; flowers with broadly expanded bases; plants perennial; local and rare in widely scattered locations in the northwestern and eastern part of the state . . 33. *E. arizonicum*

HH. Leaves tomentose or lanate; plants strictly annual.

I. Outer tepals cordate at the base, mostly oblong to orbicular.

J. Involucres deflexed.

K. Plants glabrous.

L. Involucres turbinate; flowers

white to pink; northern Arizona . . . 42. *E. deflexum*

- LL. Involucres campanulate; flowers yellow to reddish-yellow; north-central Arizona . . . 43. *E. hookeri*
- KK. Plants glandular; extreme northern Mohave Co. . . . . 44. *E. brachypodum*
- JJ. Involucres erect or horizontal on the branches, not strictly deflexed.
    - K. Stems and branches glabrous; extreme northern Mohave Co. . . . . 45. *E. insigne*
    - KK. Stems and branches scabrellous; to be expected in northeastern Arizona . . . . 46. *E. scabrellum*
- II. Outer tepals truncate to obtuse at the base.
    - J. Outer tepals pandurate, crisped along the margin; peduncles cernous to ascending; involucres 1--1.5 mm wide; northern Arizona . . . . 47. *E. cernuum*
    - JJ. Outer tepals flabellate, not crisped along the margin; peduncles stiffly erect; involucres 1.5--2.5 mm wide; southeastern Arizona . . . . 48. *E. rotundifolium*
- GG. Flowers glandular or sparsely pubescent without.
    - H. Flowers white to pink or red, glandular at the base without, with a tuft of white hairs within, the outer tepals flabellate; western and southern Arizona . . . . 49. *E. thurberi*
    - HH. Flowers yellow, or if whitish, then with saccate-dilated bases, glandular throughout.

I. Outer tepals saccate-dilated at the base; involucres 0.6--1.2 mm long, glabrous; western and southern Arizona . . . . 50. *E. thomasii*

II. Outer tepals smooth; involucres 1--2 mm long, glabrous or glandular without.

J. Flowers and involucres glandular-puberulent; bracts glandular without; western Arizona . . . . 51. *E. pusillum*

JJ. Flowers glandular-puberulent without; involucres glabrous without; bracts villous without; rare and often local, western Arizona . 52. *E. reniforme*

FF. Involucres 0.3--1 mm long.

G. Flowers yellow to red, 0.5--1.5 mm long; involucres 4-toothed; inflorescences densely branched and spreading; northeastern Arizona from Coconino Co. eastward . . . . 53. *E. wetherillii*

GG. Flowers white to pink or rose, 0.8--2 mm long; involucres 5-toothed; inflorescences open and erect; clay hills in northeastern Mohave Co., northern Coconino Co., and southern Apache Co. . . . . 54. *E. subreniforme*

EE. Leaves basal and cauline.

F. Flowers glabrous without.

G. Leaves oblong to ovate, villous to hoary on both surfaces; tepals strongly dimorphic, the outer tepals orbicular and smooth at maturity; common and widespread mainly in the southern half of the state . . . 55. *E. abertianum*

GG. Leaves linear-lanceolate to linear-oblanceolate, lanate below, villous above; tepals dimorphic, the outer tepals oblong-ovate with a large saccate part on each side of the base; common and widespread from northwestern Arizona to southeastern Arizona . . . . 56. *E. pharnaceoides*

FF. Flowers glandular-pubescent without with non-capitate hairs; tepals dimorphic, the outer tepals inflated and with a large purple spot; common in western and south-

ern Arizona . . . . . 57. *E. maculatum*

CC. Involucres angled to strongly ribbed, tightly appressed to the stems and always sessile; plants strictly annual.

D. Leaves tomentose at least below; stems and branches glabrous to tomentose.

E. Stems and branches glabrous; inflorescences open and strict, 0.5—3 dm long; involucres 3—5 mm long; flowers white, 1.5—2 mm long; local and rare in western and northern Arizona . . . . 58. *E. davidsonii*

EE. Stems and branches tomentose to floccose.

F. Leaves basal.

G. Flowers yellow to red; plants densely branched with the upper tips often curving inwardly, the crowns dense and much branched; Mohave Co. . . . . 59. *E. nidularium*

GG. Flowers white; plants open with spreading branches, the crowns open and few branched; widespread throughout all but the northeastern Arizona . . . . 60. *E. palmerianum*

FF. Leaves cauline; plants strict and erect, 1—6 dm tall; flowers white; widespread throughout the state, becoming rare in the northern part . . . . 62. *E. polycladon*

DD. Leaves, stems, and branches puberulent to villous.

E. Outer tepals oblong to ovate, not fan-shaped or hooded.

F. Stem leaves foliaceous at the lower nodes, puberulent or short pilose; involucres 5-toothed; flowers yellowish, hispidulous and often glandular, 1.5—2 mm long; common across the northern part of the state . . . . 63. *E. divaricatum*

FF. Stem leaves bractlike, silky-pubescent; involucres 4-toothed; flowers white to red, glabrous or hispidulous, 1—1.5 mm long; to be expected in extreme northern Mohave Co. . . . . 64. *E. puberulum*

EE. Outer tepals fan-shaped and hooded; plants leafy throughout and sericeous; extremely rare and local, northwestern Coconino Co. 65. *E. darrovii*

KEY TO ERIOGONUM IN NEW MEXICO

A. Plants perennial.
B. Flowers stipitate basally; low spreading cespitose to herbaceous plants with spreading woody caudices.
C. Flowers glabrous without; northwestern New Mexico . . . . 28. *E. umbellatum*
CC. Flowers pubescent without; common and widespread in the state . . . . 30. *E. jamesii*
BB. Flowers not attenuated into a stipelike base.
C. Plants cespitose to large shrubs; stems glabrous to tomentose, not strigose; achenes not winged or plump, usually enclosed by the mature flower, brown to black.
D. Plants distinct shrubs or subshrubs, woody above the caudex and not dying back completely to the ground after each year.
E. Leaves tightly revolute.
F. Inflorescences open, 0.5--5 cm long, white-tomentose to lanate, or glabrate and green; leaves 0.5--5 cm long; northwestern New Mexico . . . . 1. *E. microthecum*
FF. Inflorescences dense, 3--15 cm long, glabrous and green; leaves 1.5--6 cm long; northwestern New Mexico . . . . 4. *E. leptophyllum*
EE. Leaves flat, not tightly revolute.
F. Leaves 1.5--5 cm long; plants of the northern half of the state.
G. Inflorescences 0.2--1 dm long; leaves mostly 1--3 cm wide.
H. Stems and branches tomentose to floccose; leaves elliptical-oblong to oval, 1.5--2.5 cm long; flowers cream, 2--2.5 mm long; central and northwestern New Mexico . . . . 6. *E. corymbosum*
HH. Stems and branches glabrous or rarely floccose basally; leaves lanceolate to elliptic, 1.5--5 cm long; flowers white, 2.5--4 mm long; northeastern New Mexico . . . . 7. *E. fendlerianum*
GG. Inflorescences 1--4 dm long; leaves mostly 0.2--1 cm wide.
H. Tomentum floccose and blackish upon drying; inflorescences 1--4 dm long, the involucres dichotomously arranged throughout; leaves oblong to oblanceolate, (1) 1.5--3 cm long, (2) 3--7 mm wide; northern half of the state . . .

. . . . 5. *E. effusum*

HH. Tomentum floccose and whitish, or lacking and the stems and branches glabrous, 1--3 dm long, the involucres racemosely arranged at the tips of the branches; leaves linear-lanceolate to linear-oblanceolate, 1.5--4.5 cm long, 2--5 mm wide; San Juan Co. . . . . 9. *E. leptocladon*

FF. Leaves 0.5--1.5 cm long, 2--5 (7) mm wide, oblanceolate to elliptic; inflorescences with involucres racemosely arranged along elongated branches; involucres 2.5--3.5 mm long; flowers 2.5--3.5 mm long; common mainly in the southern half of the state . . . . 22. *E. wrightii*

DD. Plants herbaceous, cespitose or pulvinate perennials.

E. Plants herbaceous; inflorescences open.

F. Involucres not arranged racemosely along elongated branches.

G. Leaves glabrous on both surfaces with a few hairs along the margin and midvein; flowers yellow, finely white-pubescent without along the midrib and base, 1--2 mm long; rare and local in Eddy Co. . . . . . 17. *E. gypsophilum*

GG. Leaves tomentose on at least one surface; flowers white, or if yellow, then densely pubescent without with long hairs.

H. Flowers glabrous without.

I. Inflorescences umbellate and short, less than 1 cm long; flowering stems erect, 1--2.5 dm long, tomentose to floccose; reportedly collected in northern New Mexico . . . . 18. *E. brandegei*

II. Inflorescences open and divided; flowering stems glabrous.

J. Tepals monomorphic; leaves narrow, mostly linear to lanceolate or oblanceolate, 2--15 cm long; north central and northwestern New Mexico . . . . 19. *E. lonchophyllum*

JJ. Tepals dimorphic; leaves elliptic, 0.2--1.5 cm

long; northeastern New Mexico . 36. *E. tenellum*

HH. Flowers densely pubescent without.

I. Stem tomentose; inflorescences subcapitate to short cymose or umbellate, up to 6 cm long; involucres 3--4 mm long; flowers 2.5--4.5 mm long; achenes woolly, 3--4 mm long; gravelly to clay outcrops in northern New Mexico . . . . 20. *E. lachnogynum*

II. Stems glabrous; inflorescences cymose, 1--4 dm long; involucres 1.5--2.5 mm long; flowers 2--3 mm long; achenes glabrous, 2--2.5 mm long; gravelly to rocky places in southeastern New Mexico . 21. *E. havardii*

FF. Involucres racemosely arranged along elongated branches.

G. Plants suffrutescent; leaves small, 0.5--1.5 cm long; widespread and common throughout most of the southern half of the state . 22. *E. wrightii*

GG. Plants erect herbs; leaves large, 1.5--10 cm long, 1--3.5 cm wide; rather common in the coniferous forests of northwestern New Mexico . . . . 23. *E. racemosum*

EE. Plants cespitose and pulvinate; inflorescences capitate.

F. Tepals monomorphic.

G. Flowers glabrous; scapose branches 1--2.5 dm long; involucres 3.5--5 mm long; leaves 1.5--4 cm long, 4--8 mm wide; reportedly from northern New Mexico . . . . . . 18. *E. brandegei*

GG. Flowers pilose without; scapose branches up to 0.3 dm long; involucres (3) 4--6 mm long; leaves 0.3--1.2 cm long, (3) 4--6 mm wide; San Juan Co. . . . . 25. *E. shockleyi*

FF. Tepals strongly dimorphic, glabrous; scapose stems 0.4--2 dm long; involucres 4--6.5 mm long; leaves 0.5--6 cm long, 0.5--1.5 cm wide; widespread and rather common in northwestern New Mexico . . . . 26. *E. ovalifolium*

CC. Plants erect perennial herbs with strigose stems and branches, not glabrous or tomentose; achenes large,

plump and winged, yellowish to yellowish-brown.

D. Flowers yellow, pubescent without; achenes winged at the apex; widespread and common from southeastern New Mexico to west-central New Mexico . . . . 31. *E. hieracifolium*

DD. Flowers greenish to greenish-yellow, glabrous without; achenes winged the entire length; widespread and common throughout most of the state . . . . 32. *E. alatum*

AA. Plants annual or biennial, or if perennial, then stems and branches inflated and flowers hirsute without.

B. Plants perennial or biennial.

C. Plants biennial; stems strict and erect, leafy and not inflated; flowers glabrous without, tomentose within; widespread and common in eastern New Mexico . . . . 27. *E. annuum*

CC. Plants first-year flowering perennials; stems spreading, leafless and often inflated; flowers hirsute without, glabrous within; infrequent in northwestern New Mexico . . . . 34. *E. inflatum*

BB. Plants annual.

C. Involucres smooth, not ribbed or angled, usually distinctly peduncled, or if nearly sessile, then not vertically appressed to the stems.

D. Leaves glabrous, pilose, hispid or villous on one or both surfaces, not tomentose.

E. Flowers pubescent without with pilose to hirsute hairs, yellow.

F. Involucres 5-toothed; plants annual or perennial with open inflorescences, the lower nodes with 3--5 branchlets; flowers 1--3 mm long; stems often inflated; infrequent in northwestern New Mexico . . . . 34. *E. inflatum*

FF. Involucres 4-toothed; plants strictly annual with whorls of branchlets (often 5--20) radiating from the lower nodes; flowers mostly 1--2 mm long; stems usually not inflated; widespread and locally common in the southern part of the state . . . . 35. *E. trichopes*

EE. Flowers glabrous without, yellow or white.

F. Flowers yellow, 1.2--2 mm long; involucres sessile above, peduncled at the lower nodes; leaves basal and cauline, elliptic; rare and local, near Cimmaron, Colfax Co. . . . . 39. *E. aliquantum*

FF. Flowers white, 1--2.5 mm long; involucres peduncled throughout; leaves strictly basal, obovate to round or reniform; infrequent in northwestern New Mexico . . .

. . . . 40. *E. gordonii*

DD. Leaves tomentose to lanate below.

E. Leaves strictly basal or sheathing up the lower stems, not at the lower nodes.

F. Involucres 1—3 mm long.

G. Flowers yellow; involucres deflexed, sessile, broadly campanulate; to be expected in extreme northwestern San Juan Co. . . . . 43. *E. hookeri*

GG. Flowers white; involucres peduncled, turbinate, or if sessile, then stems scabrellous.

H. Stems and branches scabrellous; flowers white but turning reddish, 1—1.5 mm long, pustulose; involucres sessile and horizontal along the branches; to be expected in extreme northwestern San Juan Co. . . . . 46. *E. scabrellum*

HH. Stems and branches smooth; flowers smooth; involucres peduncled.

I. Outer tepals pandurate, crisped along the margin; peduncles cernous to ascending; involucres 1—1.5 mm wide; widespread and rather common in northwestern and north-central New Mexico . . . . . 47. *E. cernuum*

II. Outer tepals flabellate, not crisped along the margin; peduncles stiffly erect; involucres 1.5—2.5 mm wide; widespread and common in the southern half of the state . . . . 48. *E. rotundifolium*

FF. Involucres 0.3—1 mm long.

G. Flowers yellow to red, 0.5—1.5 mm long; involucres 4-toothed; inflorescences densely branched and spreading; northwestern San Juan Co. . . . . 53. *E. wetherillii*

GG. Flowers white to pink or rose, 0.8—2 mm long; involucres 5-toothed; inflorescences open and erect; clay hills in McKinley Co. . . 54. *E. subreniforme*

EE. Leaves basal and cauline.

F. Leaves oblong to ovate, villous to hoary on both surfaces; tepals strongly dimorphic, the outer tepals orbicular and smooth at maturity; common and widespread throughout the state . 55. *E. abertianum*

FF. Leaves linear-lanceolate to linear-oblanceolate, lanate below, villous above; tepals dimorphic, the outer tepals oblong-ovate with a large saccate base on each side at the base; common and widespread in the mountains of western New Mexico . . . . 56. *E. pharnaceoides*

CC. Involucres angled to strongly ribbed, tightly appressed to the stems and always sessile; plants strictly annuals.

D. Stems densely tomentose; leaves basal, or if cauline, then densely tomentose on both surfaces; flowers glabrous.

E. Leaves basal.

F. Plants open and spreading with only a few scattered involucres along the branches, 1—3 dm high; involucres campanulate, 1.5--2 mm long; rather common but local in the mountains of southwestern New Mexico . . . . 60. *E. palmerianum*

FF. Plants dense and compact with numerous congested involucres tightly arranged on the branches, 0.5—1.5 dm high; involucres turbinate, 1—1.5 mm long; rare and perhaps extinct, Grant Co. . 61. *E. densum*

EE. Leaves cauline; plants strict and erect, 1—6 dm tall; flowers white; widespread throughout the southern part of the state . . . . 62. *E. polycladon*

DD. Leaves, stems and branches puberulent or short pilose and green; leaves basal and cauline; flowers hispidulous and often glandular; infrequent in northwestern New Mexico . 63. *E. divaricatum*

SUBGENUS EUCYCLA (NUTT.) KUNTZE

1. E. MICROTHECUM Nutt. Low to tall, spreading to erect, open to compact subshrubs or shrubs 0.4--10 dm high, 0.3--1.2 m across; leaves mostly elliptic, 0.5--2 (2.5) cm long, 0.5--6 mm wide, tomentose below, slightly less so to nearly glabrous above, the margin flat or revolute, the petiole 0.5--5 mm long; stems 1-8 (40) cm long, tomentose to floccose or glabrous and green; inflorescences cymose, rather congested and compact, 1--6 (8) cm long, 1--8 cm wide, tomentose to glabrous; peduncles, when present, up to 1 cm long, tomentose to glabrous; involucres turbinate, 2--3 (3.5) mm long, 1.3--2.5 (3) mm wide, tomentose to floccose or rarely glabrous, the 5 rounded to triangular teeth (0.3) 0.5--1 mm long; flowers white with green to reddish-brown midribs and bases, 2--3 mm long, glabrous, the tepals obovate, those of the inner whorl slightly narrower; achenes light brown to brown, 2--3 mm long. -- Wide-

spread desert and montane shrub of e. Wash. s. to s. Calif., e. across Ida., Nev. and Utah to w. Mont., w. Wyo., w. and s. Colo., and into n. Ariz. and nw N.M. Jun-Oct.

The *Eriogonum microthecum* complex is composed of nine varieties found throughout much of the western United States (Reveal 1971). In Arizona and New Mexico, only two variants occur, with var. *laxiflorum* restricted to a few scattered locations in northern Arizona where it often intergrades into the more common and widespread var. *foliosum*. Forms of this species are sometimes confused with the related *E. ericifolium* var. *pulchrum* in eastern Mohave County.

VAR. LAXIFLORUM Hook. [*E. macdougalii* Gandoger. *E. microthecum* ssp. *l.* (Hook.) S. Stokes. *E. microthecum* var. *macdougalii* (Gandoger) S. Stokes.] Low to erect, spreading to sparsely branched subshrubs or low shrubs (1) 2--4 (5) dm high, 2--8 dm across; leaves mostly elliptic, (0.5) 1--2 (2.5) cm long, (1.5) 2.5--6 mm wide, densely to sparsely white-tomentose below, less so to floccose above, the margin plane or with thickened margins, not revolute; stems 2--6 (8) cm long, floccose to sparsely tomentose when young, becoming glabrous or subglabrous and greenish; inflorescences (1) 2--4 (8) cm long, floccose to glabrous; involucres 2--3 (3.5) mm long, mostly subglabrous or glabrous; flowers white, 2--3 mm long. -- Local and restricted mainly on the Kaibab Plateau in n. Ariz., with widely scattered populations near Peach Springs, Mohave Co. and in n. Apache Co.; e. Wash. to w. Mont. s. to e. Calif., s. Nev. and n. Ariz. Jun-Sep.

This variety reaches its southernmost point of distribution in northern Arizona. The type of *Eriogonum macdougalii* represents a population of seemingly intermediate plants between var. *laxiflorum* and var. *foliosum*, with the majority of specimens of the type belonging to typical var. *laxiflorum*.

VAR. FOLIOSUM (Torr. & Gray) Reveal. [*E. effusum* Nutt. var. *f.* Torr. & Gray. *E. simpsonii* Benth. in DC. *E. m.* var. *rigidum* Eastw. *E. e.* ssp. *s.* (Benth. in DC.) S. Stokes. *E. e.* ssp. *r.* (Eastw.) S. Stokes.] Low to erect, spreading to sparsely branched subshrubs or shrubs 1--10 dm high, 1--12 dm across; leaves mostly narrowly elliptic, 0.5--1.8 (2) cm long, (0.5) 1--2 (2.5) mm wide, densely white-tomentose below, floccose and whitish-green above, rarely subglabrous or glabrous and green above as in eastern Arizona and northwestern New Mexico, the margin revolute; stems 2--7 (40) cm long, densely lanate to tomentose or rarely subglabrous and greenish in plants with stems up to 40 cm long; inflorescences (1.5) 2--4 (6) cm long, tomentose to floccose or rarely subglabrous at maturity in northwestern New Mexico; flowers white, 2--3 mm long. -- Clay hills and slopes to rocky and gravelly places often on limestone outcrops from Mohave Co., Ariz. e. to Rio Arriba Co., N.M., then s. to Yavapai Co., Ariz., and from Valencia Co. to Torrance Co., N.M.; s. Calif. and Nev. e. across s. and e. Utah to w. and s. Colo., n. Ariz. and nw. N.M. Jun-Oct.

The var. *foliosum* is currently defined to include at least

three discordant elements. The types of *Eriogonum effusum* var. *foliosum*, *E. simpsonii*, and *E. microthecum* var. *rigidum* represent a low, compact plant with narrowly revolute leaves, compact inflorescences, and a stature of something less than 5 dm. In parts of northeastern Arizona, and especially in northwestern New Mexico, a second phase of var. *foliosum* occurs which may be recognized by its narrowly revolute leaves, small and compact inflorescences, but a stature that varies from 5 to 10 dm. These latter plants are often remarkably glabrous, bright green in color especially on the stems and branches, and tend to be strictly erect and not spreading as is found in typical var. *foliosum*. The third aspect of the taxon is known to me only from herbarium material randomly gathered on the eastern fringe of the taxon's range in central New Mexico. It too has narrowly revolute leaves but which tend to be longer and narrower (by and large) from the other phases, with a somewhat longer inflorescences that tends to be more branched, and by a stature that varies from 4 to 6 dm. Unlike all other forms of the species, however, this third phase blackens upon drying and in the herbarium is very distinctive. All of these phases tend to blend into one another across northern Arizona and New Mexico, but when observed singly can be striking.

2. E. RIPLEYI J. T. Howell. Low, heavily branched subshrubs 0.5--1.5 (2) dm high, 0.5--3 (5) dm across; leaves narrowly oblanceolate, 2--6 mm long, 0.5--1 mm wide, densely white-tomentose below, thinly floccose to villous and greenish above, the margin strongly revolute, the petiole (0.5) 1--1.5 mm long; stems indistinguishable from the other branches, woody; inflorescences reduced to a cymose-umbel consisting entirely of a single involucre arising from the apex of each erect shoot; bracts lacking; peduncles slender, thinly floccose, 1--10 mm long, erect, terminating the erect shoot; involucres solitary, campanulate, 3--3.5 mm long and wide, thinly floccose or villous to subglabrous without, the 3--5 unequal acute teeth 0.7--1 mm long; flowers white with reddish-brown midribs and bases, 3.5--4.5 mm long, glabrous, the tepals dimorphic, the outer tepals suborbicular, 3--3.5 mm long, 3.5--4 mm wide, the inner tepals broadly obovate, 2.8--3.2 mm long, 2-2.5 mm wide; achenes light brown to brown, 2--2.5 mm long. -- Rare and restricted to sandy clay soil on the edges of sandstone mesas associated with pinyon-juniper, sw. of Frasier's Well and near Peach Springs in sw. Coconino and adjacent e. Mohave cos., and at the n. end of Horseshoe Dam on calcarerous soils, Yavapai Co., Ariz. Apr-Jun.

This species is "threatened" because of its attractiveness to gardeners, the heavy overgrazing of the Hualapai Indian Reservation and the increased use of the Horseshoe Dam area as a recreational facility. The species was described by Howell in 1944.

3. E. ERICIFOLIUM Torr. & Gray. Low spreading pulvinate subshrubs 0.5--0.9 (1.2) dm high, 0.8--2 (3.5) dm across; leaves oblanceolate to narrowly elliptic, 5--8 mm long, 0.8--1.5 (2) mm

wide, densely white-tomentose below, glabrous and green to floccose and whitish-green above, the margin revolute or at least thickened, the petiole 1.5--2 mm long; stems slender, 0.3--2 cm long, floccose to slightly tomentose, the area among the leaves remaining floccose to tomentose or rarely glabrate; inflorescences cymose-umbellate, compact and congested, 0.5--1 cm long, 0.5--1.5 cm wide, sparsely tomentose to floccose; peduncles lacking; involucres solitary, turbinate, 2.5--3 mm long, 1.5--2 mm wide, slightly pubescent without, the 5 acute teeth 0.4--1 mm long; flowers white with reddish-brown midribs, becoming tinged with pink or red to rose at maturity, 2--2.5 mm long, glabrous, the tepals dimorphic, those of outer whorl broadly obovate to nearly orbicular, 2--2.5 mm wide, those of the inner whorl oblanceolate to oblong, 0.8--1.2 mm wide; achenes light brown, 2--2.5 mm long. -- Dry gravelly to rocky sites in pinyon-juniper woodlands from extreme Mohave Co. e to s. Navajo Co., with isolated populations in Yavapai Co., Ariz., and San Bernardino Co., Calif. Aug-Oct.

VAR. PULCHRUM (Eastw.) Reveal. [*E. p.* Eastw. *E. microthecum* Nutt. ssp. *p.* (Eastw.) S. Stokes. *E. mearnsii* Parry in Britton var. *p.* (Eastw.) Kearney & Peebles.] Low spreading subshrubs 0.8--1.2 dm high; leaves 5--8 mm long, floccose and whitish-green above, slightly revolute or with thickened margins; flowers 2--2.5 mm long, the outer tepals nearly orbicular, 2--2.5 mm wide. -- Often common and widespread in n. Ariz. from extreme e. Mohave Co. e. across se. Coconino Co. into s. Navajo Co., mostly along the Mogollon Rim.

This is the common phase of the species, and is frequently incountered in southeastern Coconino and southern Navajo counties. The one known collection from the Toroweap Point area of Mohave Co. is somewhat similar to *Eriogonum microthecum*, and the two are difficult to separate in this area.

VAR. ERICIFOLIUM. [*E. mearnsii* Parry in Britton. *E. fasciculatum* Benth. var. *e.* (Torr. & Gray) M. E. Jones. *E. microthecum* Nutt. ssp. *e.* (Torr. & Gray) S. Stokes. *E. microthecum* ssp. *m.* (Parry in Britton) S. Stokes.] Low spreading subshrubs 0.5--0.8 dm high; leaves 5--6 mm long, glabrous and green above, tightly revolute; flowers 2.5--3 mm long, the outer tepals obovate, 2 mm wide. -- Rare and exceedingly local, known only from near Prescott and Camp Verde, Yavapai Co., Ariz. Aug-Oct.

At one time I thought this taxon was possibly extinct, as it was known to me (Reveal 1971) from only two collections, the type of *Eriogonum ericifolium* and the type of *E. mearnsii*. Since then I have located two additional collections made by H. Scott Gentry on Prescott Mountain (*Gentry 3093*) and in Verde River Valley (*Gentry 3986*); both were gathered in the late 1930s. I still regard the taxon as "endangered". Recently, a third form of the species has been described. This is var. *thornei* Reveal & Henrickson (1975) from the New York Mountains, San Bernardino Co., California. It is most closely related to var. *ericifolium*.

4. E. LEPTOPHYLLUM (Torr. in Sitgr.) Wooton & Standley. [*E. effusum* Nutt. var. *l.* Torr. in Sitgr. *E. microthecum* Nutt. var. *l.* (Torr. in Sitgr.) Torr. & Gray.] Large, rounded, heavily-branched shrubs 2--6 dm high, 0.3--1 m across; leaves linear to linear-oblanceolate, (1.5) 2--6 cm long, (0.8) 1--2.5 (3) mm wide, densely to thinly white-tomentose below, glabrous and green above, the margin tightly revolute, the petiole 0.4--1 mm long; stems 1--8 cm long, glabrous; inflorescences cymose, dense and broomlike with numerous glabrous branches, 2--15 cm long, 4--15 cm wide; involucres narrowly turbinate, 2--3 mm long, 1.1--1.7 (2) mm wide, glabrous, the 5 acute teeth 0.3--0.7 mm long; flowers white with greenish-brown midribs and bases, 2.5--4 mm long, glabrous, the tepals oblong to narrowly obovate; achenes brown, 3.5--4 mm long. -- Local and frequently common from se. Utah and sw. Colo. s. to ne. Ariz. and nw. N.M., ranging from extreme e. Coconino Co. e. to Taos Co. s. to Bernalillo Co. Jul-Oct.

This is one of the more elegant shrubs in the genus, and on the barren clays and volcanic soils of northwestern New Mexico, the bright green foliage and white flowers of *Eriogonum leptophyllum* can make a spectacular sight. The thin to slender branches of the inflorescence, coupled with their density, make this species easy to distinguish from *E. microthecum*.

5. E. EFFUSUM Nutt. [*E. microthecum* Nutt. var. *e.* (Nutt.) Torr. & Gray.] Diffusely branched shrubs (1.5) 2--5 (7) dm high, 0.3--1.5 m across; leaves oblanceolate to oblong, (1) 1.5--3 cm long, (2) 3--7 mm wide, densely white- to gray-tomentose below, white-floccose to glabrate or glabrous and green (rare in our area) above, the margin plane, the petiole 2--7 mm long; stems slender to stoutish, 3--8 cm long, floccose to glabrous; inflorescences densely cymose, diffuse and usually congested or (in western New Mexico) open, 1--3 (4) dm long, floccose to glabrate; peduncles, when present, slender and up to 2.5 cm long, mostly floccose and restricted to the lower nodes; involucres turbinate, 1.5--2.5 (3) mm long, sparsely floccose without, the 5 minute acute to triangular teeth 0.3--0.6 mm long; flowers white with greenish or reddish midribs and bases, 2--4 mm long, glabrous, the tepals elliptic to obovate, the inner tepals slightly narrower; achenes brown, 2--3 mm long. -- Dry rocky slopes to sandy plains or infrequently on clay, chalky, or gypsum outcrops in the Great Plains from w. S.D. and e. Wyo. s. to s. Colo., and in the mountains of se. Wyo. s. through central Colo. to n.-central and nw. N.M.; from e. San Juan Co., N.M. e. to Union Co. s. to Socorro Co. Jun-Sep.

In New Mexico, *Eriogonum effusum* presents a difficult set of problems which even now are not totally resolved. The isolated Socorro Co. population (*Reveal & Davidse 918*) is rather typical of the kind of plant one finds of this species in Colorado, Wyoming, and Nebraska. The populations which occur from San Juan Co. to Sandoval Co., on the other hand, are unique as they differ in being more open, robust plants with dense tomentum, somewhat larger leaf-blabes, and an inflorescence that is composed of fewer branches

with generally widely scattered involucres. In north-central New Mexico, these plants appear to be more similar to the general aspect of *E. effusum* than the plants of San Juan Co. In the latter area, the plants clearly grade morphologically into *E. leptocladon* in a gross fashion. However, the two do not seem to hybridize as when the two species have died back in the winter, the over-wintering plants of *E. leptocladon* are reddish, and those of *E. effusum* are grayish, and the two can be easily distinguished. As one may note from the distribution map of *E. effusum* var. *effusum* published in 1971 (Reveal 1971, fig. 24), the New Mexico plants are well isolated from the remaining populations of the species, and continued research may ultimately reveal a need to distinguish the northwestern populations of this species as a distinct taxon.

6. E. CORYMBOSUM Benth. in DC. Low spreading shrubs (ours) or subshrubs (2) 3--8 (12) dm high, 0.4--1.5 (2) m across; leaves lanceolate to oblanceolate or elliptic to nearly orbicular, 1--3 (4.5) cm long, (0.3) 0.5--3 (3.5) cm wide, densely white-tomentose on both surfaces or less so to subglabrous or glabrous and green above in some, the margin entire or crenulate, not revolute, the petiole 2--15 mm long; stems (0.5) 1--2 dm long, tomentose to subglabrous or rarely glabrous; inflorescences cymose, (1) 2.5--20 cm long, 2--30 cm wide, tomentose to glabrous; involucres turbinate, 1.5--3.5 mm long, 1--2 (2.5) mm wide, tomentose to glabrous without, the 5 acute teeth 0.3--1 mm long; flowers white with greenish or reddish midribs and bases, whitish-brown with reddish bases, or yellow with reddish bases, 2.5--3.5 (4) mm long, glabrous, the tepals oblanceolate to spatulate, the inner tepals slightly narrower; achenes brown, 2--2.5 (3) mm long. -- Rather common on clay hills and flats or on rocky outcrops from sw. Wyo. s. through e. and s. Utah to n. Ariz., and e. to w. Colo and n. N.M., with an isolated population in s. Nev. Jul-Oct.

Since my revision of this species complex (Reveal 1968b), I have modified my views on this species, even to the point of recognizing one element I regarded as a synonym in 1968 (var. *divaricatum* Torr. & Gray) and another I reduced in 1973 (Reveal 1973), var. *revealianum* (S. L. Welsh) Reveal (Welsh, et al. 1976). As for the species, as it occurs in Arizona and New Mexico, I have now found specimens of var. *velutinum* Reveal in extreme eastern Arizona, and have found var. *orbiculatum* (S. Stokes) Reveal & Brotherson in northwestern New Mexico. The following key should discriminate among the various taxa in the two states.

KEY TO THE VARIETIES

A. Flowers white to brownish-white, not yellow.
   B. Leaves oblanceolate to elliptic, 1--3 (4.5) cm long, 1--2 cm wide, the petiole 2--6 mm long; branches white-tomentose; northern Arizona . . . . var. *corymbosum*
   BB. Leaves elliptical-oblong to nearly orbicular, 1--3 (4) cm long, 1--3 (3.5) cm wide, the petiole 5--10 (15) mm long,

C. Plants greenish; leaves mostly thinly tomentose below, subglabrous to glabrous and green above; flowers 2.5--3 mm long; mostly in sandy places, northeastern Arizona and northwestern New Mexico . . . . var. *orbiculatum*

CC. Plants brownish-white; leaves densely tomentose below, floccose above; flowers 2--2.5 mm long; mostly on clay hills and rocky outcrops, northern New Mexico and east central Apache Co., Arizona . . . . . var. *velutinum*

AA. Flowers yellow; stems and branches glabrous to floccose; northern Arizona . . . . var. *glutinosum*

VAR. CORYMBOSUM. [*E. effusum* Nutt. ssp. *c.* (Benth. in DC.) S. Stokes.] Subshrubs to shrubs 3--8 dm high, the crown suberect to subglobose, up to 1 m across; leaves lanceolate to oblanceolate or elliptic, 1--3 (4.5) cm long, (0.3) 0.5--1 (1.5) cm wide; inflorescences 3--10 cm long, usually densely tomentose; involucres 1.5--2.5 mm long, 1--1.5 mm wide; flowers white, 2--3 (3.5) mm long. -- Dry clay hills and rocky outcrops in e. Mohave and Coconino cos., Ariz.; widespread from e. Utah and w. Colo. s. to n. Ariz. Jul--Sep.

VAR. ORBICULATUM (S. Stokes) Reveal & Brotherson. [*E. effusum* Nutt. ssp. *o.* S. Stokes.] Large compact and hemispheric shrubs (3) 5--12 dm high, 0.5--2 m across; leaves mostly orbicular, 1--3 cm long and wide, floccose to thinly tomentose on both surfaces, usually deep green; inflorescences dense, up to 2 dm long and 3 dm across, of rigid branches; flowers white, 2.5--3 mm long. -- In sandy soil mainly in the Colorado River drainage from north-central Coconino Co. e. across Navajo and Apache cos., Ariz. to San Juan and McKinley cos., N.M.

The New Mexico plants approach var. *velutinum*, but by and large can be distinguished by the more open habit and more dense tomentum than var. *orbiculatum*. The var. *orbiculatum* is best developed in the Four Corners area, and especially in Monument Valley.

VAR. VELUTINUM Reveal. Large shrubs 5--10 dm high, 0.5--2 m across; leaves mostly oblong, 2--2.5 (3.5) cm long, 1.5--2.5 (3) cm wide, densely tomentose below, floccose and whitish above; inflorescences dense to ± open, 4--10 cm long, of stout but not rigid branches; flowers brownish-white, 2--2.5 mm long. -- Usually on clay soils or rocky outcrops of se. Utah, sw. Colo., e. Ariz., and nw. N.M.; from Apache Co., Ariz. e to Sandoval and Santa Fe cos. s. to Socorro Co., N.M. Jul-Oct.

In my 1968 revision (Reveal 1968b), I considered this variant to be restricted to New Mexico. In my review of the genus for the state of Utah, I expanded the range to include a series of plants in San Juan Co. and a few scattered individuals in adjacent southwestern Colorado (Reveal 1973). At that time, I mentioned that var. *velutinum* also occurred in eastern Arizona, but did not give any details. My few Arizona specimens are from the Many Farm and Kayenta areas of Apache Co.

VAR. GLUTINOSUM (M. E. Jones) M. E. Jones. [*E. aureum* M. E. Jones. *E. a.* var. *g.* M. E. Jones. *E. fruticosum* A. Nels. *E. f.* var. *g.* (M. E. Jones) A. Nels. *E. microthecum* Nutt. ssp. *a.* (M. E. Jones) S. Stokes.] Low subshrubs to large rounded shrubs 2--10 dm high, (3) 5--20 dm across; leaves lanceolate to oblanceolate or elliptic, 1--4 cm long, 0.5--1.5 cm wide; inflorescences 3--10 cm long, glabrous to tomentose; involucres 1--2 mm long, 1--1.5 (2) mm wide; flowers yellow, 1.5--2.5 mm long. -- Rather common in sandy to gravelly or even rocky places throughout much of n. Ariz. from Mohave Co. e. to Apache Co.; s. Utah and s. Nev. Jul-Oct.

For the most part, the var. *glutinosum* may be easily distinguished by the yellow flowers which so strikingly set this plant apart from the desert landscape in the volcanic areas of northern Arizona. However, around House Rock in Coconino Co., var. *glutinosum* intergrades with var. *corymbosum* producing a series of individuals which vary from pale yellow to bright yellow in terms of flower color, and from densely tomentose to nearly glabrous in terms of stem and branch tomentum. The two are usually slightly separated either elevationally or edaphically throughout their overlapping range. The continued attempt to maintain the yellow flowered phase as a distinct species (McDougall 1973) is unwarranted.

7. E. FENDLERIANUM (Benth. in DC.) Small. [*E. microthecum* Nutt. var. *f.* Benth. in DC. *E. ainslei* Wooton & Standley. *E. effusum* Nutt. ssp. *f.* (Benth. in DC.) S. Stokes. *E. e.* var. *a.* (Wooton & Standley) S. Stokes.] Low subshrubs or shrubs (1) 1.5--4 (5) dm high, 2--6 (8) dm across; leaves lanceolate to elliptic, 1.5--4 (5) cm long, (0.3) 0.5--2 cm wide, entire or crenulate along the margin, densely white-tomentose below, subglabrous to glabrous and greenish above, the petiole 5--20 mm long; stems 3--15 (20) cm long, densely tomentose among the leaves below, glabrous or rarely floccose above; inflorescences open, 2--10 cm long; involucres turbinate to turbinate-campanulate, 2.5--3.5 (4) mm long, 1.5--3.5 mm wide, glabrous or essentially so without, the 5 acute teeth 0.5--1 mm long; flowers white with brownish midribs and bases, 2.5--3.5 (4) mm long, glabrous, the tepals elliptic to oblong, those of the inner whorl slightly narrower; achenes brown, 2--2.5 mm long. -- Local and often rather common on clay or barren hillsides or outcrops, from sw. Colo. to e. Colo. and s. to ne. N.M. and adjacent Tex.; from Rio Arriba Co. to Colfax Co., with an isolated population in Quay Co., N.M. Jun-Oct.

My own understanding of this species is currently undergoing some revision and I may ultimate modify the concept of the species as presented in 1968 (Reveal 1968b). The problem has to do with the exact identity of the Fendler type of var. *fendlerianum* which was collected at Rock Creek in Taos Co., New Mexico. The plants of western Colorado that I associated with this name may be better associated with *E. lonchophyllum* Torr. & Gray. However, the type of var. *fendlerianum* may ultimately fall into this category, and if so then the next available name for the plants of south-central

Colorado and Colfax and Quay counties of New Mexico is *E. ainslei*. Until I can do the necessary field work, this small problem must remain unresolved.

8. E. JONESII S. Wats. [*E. lanosum* Eastw.] Low, spreading subshrubs 2--4.5 dm high, 3--8 dm across; leaves sheathing up the lower stems, cordate, (1.5) 2--2.5 cm long, 1--2 (2.5) cm wide, densely white-tomentose below, floccose and greenish- or brownish-white above, the margin entire or crenulate, the petiole 1.5--3 cm long; stems tomentose, densely so among the leaves below, becoming less so to merely floccose above, 1--2.5 dm long; inflorescences mostly open, cymose, 3--15 cm long, tomentose; involucres turbinate, 1.5--2 mm long, 1--1.3 mm wide, tomentose without, the 5--6 acute teeth 0.5--0.8 mm long; flowers brownish-white with brownish-red midribs and bases, 2--3 mm long, glabrous, the tepals dimorphic, the outer tepals obovate, 1.8--2 mm wide, the inner tepals lanceolate to narrowly elliptic, 1--1.2 mm wide; achenes light to dark brown, 2--2.5 mm long. -- Local and often infrequent in sandstone, limestone, or otherwise rocky areas in protected sites in n. Ariz. from extreme e.-central Mohave Co. e. across central Coconino Co. to extreme w. Navajo Co. Aug-Oct.

Since my review of this species (Reveal 1968e), little additional information has been obtained upon the taxon except in terms of additional locations where it grows. It is doubtful that McDougall (1973) saw my review as the species is more widespread than he indicates, and one of the many typographical errors of his book would seem to imply that the involucre is both tomentose and glabrous.

9. E. LEPTOCLADON Torr. & Gray. Large erect to spreading diffusely branched shrubs (2) 3--10 (13) dm high, 0.5--1.5 (2) m across; leaves linear-lanceolate to linear-oblanceolate or narrowly oblong, 1.5--4.5 cm long, 2--8 mm wide, densely white-tomentose below, less so and often greenish above, the margin slightly revolute in some, the petiole 2--5 mm long; stems 3--10 cm long, tomentose to floccose or glabrous; inflorescences large, open, cymose, 1--4 dm long, 1--5 dm across, lightly tomentose to floccose or glabrous, the involucres racemosely arranged at the tips of the branches and branchlets; involucres turbinate to turbinate-campanulate, 1.5--3 mm long, 1--2 mm wide, tomentose to glabrous without, the 5 acute to rounded teeth 0.4--0.7 mm long; flowers white or pale-yellow to yellow with reddish-brown to brown midribs and bases, (2) 2.5--3.5 mm long, glabrous, the tepals obovate to nearly fan-shaped; achenes light brown, 2.5--3.5 mm long. -- Sandy places mainly on flats and gentle slopes from e. Utah s. to ne. Ariz. and nw. N.M.; local and frequently abundant from Coconino Co., Ariz. e. to San Juan Co., N.M.

The var. *leptocladon* occurs only in eastern Utah, and is distinguished from the two variants reported here in having yellowish flowers and thinly pubescent stems and branches.

VAR. RAMOSISSIMUM (Eastw.) Reveal. [*E. r.* Eastw. *E. eastwoodae*

M. E. Jones. *E. pallidum* Small. *E. effusum* Nutt. var. *p.* (Small) S. Stokes.] Stems tomentose to floccose; flowers white. -- Common in sandy places in e. Utah, sw. Colo., ne. Ariz., and nw. N.M.; from Coconino Co., Ariz. e. across the n. tier of cos. to San Juan Co., N.M. Jun-Oct.

In an early review of this species (Reveal 1966), I associated a small series of western Arizona plants with var. *ramosissimum*, but subsequent field work in Mohave Co., Arizona, and Washington Co., Utah, show these populations to be *Eriogonum kearneyi*.

VAR. PAPILIUNCULI Reveal. Stems glabrous; flowers white. -- Local and often rare in s.-central Utah, ne. Ariz., and nw. N.M.; in moving sands from near Page, Coconino Co. e. to Monument Valley, Ariz., and in Cutler Canyon, San Juan Co., N.M. Aug-Oct.

Although this taxon was just recently described (Reveal 1974a) specimens of it have been known for many years and associated with either *Eriogonum corymbosum*, the var. *ramosissimum*, or left unnamed. In the Page area, the taxon is rather common, and seems to be an important plant in stabilizing sand dunes.

10. E. KEARNEYI Tidestr. [*E. nodosum* Small var. *k.* (Small) S. Stokes.] Low to tall spreading subshrubs or shrubs 2--8 dm high, 0.3--1 (1.3) m across; leaves broadly oblanceolate to elliptic, 1--2.5 (3) cm long, 4--12 (15) mm wide, densely white-tomentose below, slightly less so and greenish above, the margin not revolute, the petiole 2--10 mm long; stems 5--10 cm long, tomentose; inflorescences large, open, cymose, 0.5--5 dm long, 0.5--8 dm across, tomentose, the involucres racemosely arranged at the tips of the branches; peduncles, when present, up to 5 mm long, tomentose; involucres turbinate, 2--2.5 mm long, 1.5--2 mm wide, tomentose without, the 5 acute teeth 0.1--0.4 mm long; flowers white with reddish to reddish-brown midribs and bases, 1.5--3 mm long, glabrous, the tepals obovate, those of the inner whorl slightly narrower; achenes light brown, 2--3 mm long. -- Sandy places in w. and sw. Utah s. to nw. Ariz., then w. across the s. half of Nev. to e. Calif.; rare and local, known only from n. Mohave Co. and w. Coconino cos. in Ariz. Jul-Sep.

In Kane Co., Utah, and adjacent portions of northern Coconino and Mohave cos., Arizona, the distinction between this species and *Eriogonum leptocladon* var. *ramosissimum* is somewhat subjective. For the most part, the leaves of *E. kearneyi* are shorter and broader than those of var. *ramosissimum*, and this is about the only simple feature that can be used to separate the two. Once both are known, however, the denser degree of tomentum of *E. kearneyi* will be noted as will the more clustered arrangement of the involucres at the tips of the branches in *E. kearneyi* when compared with *E. leptocladon*. Unlike the type of over-winter distinction that can be made between the New Mexico populations of var. *ramosissimum* and *E. effusum*, the dried shrub color of the two Arizona plants is essentially the same. The Arizona plant is var. *kearneyi*, with the var. *monoense* (S. Stokes) Reveal restricted to eastern California.

11. E. MORTONIANUM Reveal. Large erect totally glabrous shrubs 4--8 (10) dm high, 0.5--1 (1.3) m across; leaves elliptic, 1.5--4 (4.5) cm long, (3) 6--10 (12) mm wide, the margin thickened but not revolute, the petiole (2) 3--8 (10) mm long; stems 5--10 (12) cm long; inflorescences large, open, cymose, 15--25 cm long, 15--30 cm wide, pale yellowish-green; involucres turbinate, 2--2.5 mm long, 1.2--1.8 (2) mm wide, the 5 acute teeth 0.3--0.4 mm long; flowers pale-yellow or white, (2) 2.5--3 mm long, glabrous, the tepals obovate, those of the inner whorl slightly narrower; achenes light brown, 3--3.5 mm long. -- Restricted to red clay hills 4.5 mi sw. of Fredonia in Mohave Co., Ariz. Jul-Sep.

This newly described species (Reveal 1974a) is considered to be "endangered" first because of its rareness and close association with Arizona Highway 389, and secondly because of the overgrazing noted on the Kaibab Indian Reservation upon which land the species is restricted. The species grows with two other species which are considered endangered or threatened, *Eriogonum thompsonae* var. *atwoodii* and *Cryptantha subglabra* Barneby.

12. E. FASCICULATUM Benth. var. POLIFOLIUM (Benth. in DC.) Torr. & Gray. [*E. p.* Benth. *E. revolutum* Goodding. *E. f.* ssp. *p.* (Benth. in DC.) S. Stokes. *E. f.* var. *r.* (Goodding) S. Stokes.] Low rounded and ± compact or spreading subshrubs or shrubs 2--5 (8) dm high, 3--10 dm across; leaves fascicled, mostly oblanceolate, 6--18 mm long, (1) 2--6 mm wide, often revolute, canescent on both surfaces or tomentose below and canescent above; stems 3--15 cm long, thinly tomentose to canescent; inflorescences congested or nearly so, occasionally umbellate and open; involucres turbinate to turbinate-campanulate, 2.5--3.5 mm long, 2--3.5 mm wide, pubescent without; flowers white to pink, 2.5--3 mm long, pubescent without on the base and midrib; achenes light brown, 2--2.5 mm long. -- Rocky places mostly in the low desert ranges of nearly all but the ne. portion of Ariz.; widespread and common from sw. Utah s. to w. and s. Ariz., w. to Baja Calif. and e. Calif. Apr-Jul (Oct).

This is one of the more common desert shrubs, and probably the most abundant shrubby species of the genus *Eriogonum* in Arizona. It is the only large shrub of the genus with pubescent flowers, and as such may be quickly identified. The var. *flavoviride* Munz & I. M. Johnston may eventually be found in western Yuma Co. It differs from var. *polifolium* in being yellow-green in color instead of grayish, and having glabrous peduncles and involucres. A second shrubby species with pubescent flowers that may eventually be seen in extreme southwestern Yuma Co. is *E. deserticola* S. Wats. It differs from var. *polifolium* in having yellow-colored flowers that are densely covered with white hair; it also flowers from September to December, and occurs only on deep, moving sands.

13. E. HEERMANNII Dur. & Hilg. Low spreading to large erect and rounded subshrubs or shrubs 1--20 dm high, 1--25 dm across; leaves linear, oblanceolate to spatulate or oblong-lanceolate,

(0.5) 1--2 (3) cm long, 1--8 mm wide, tomentose to thinly floccose or glabrous below, thinly floccose to glabrous above, the margin usually plane or only slightly revolute, the petiole 3--10 mm long; stems slender to stout, 0.3--4 cm long, floccose to glabrous, smooth to scabrellous, terete or angled; inflorescences open to densely clustered cymes with rigid branches, 1--20 (25) cm long and wide, floccose to glabrous, smooth to scabrellous, terete or angled and deeply grooved; involucres campanulate, 0.7--2 mm long, 0.8--3 mm wide, glabrous without, the 5 rounded teeth 0.3--0.7 mm long; flowers white to yellowish-white with greenish or reddish midribs and bases, often maturing pinkish or rose, 2--4 mm long, glabrous, the tepals dimorphic, those of the outer whorl obovate to orbicular, those of the inner whorl lanceolate to oblong; achenes light brown to brown, 2--2.5 mm long. -- Widespread in rocky or gravelly places usually on limestone outcrops or infrequently on sandstone ledges from s. and e. Calif. e. to sw. Utah and nw. and n.-central Ariz.; in widely scattered locations mainly in Mohave and Coconino cos. Jun-Oct.

As now defined, *Eriogonum heermannii* is composed of eight varieties. The most common and widespread phase is var. *humilius* (S. Stokes) Reveal of eastern Califorina and Nevada. The typical variety is restricted to southern California and is close related to a coastal montane phase, var. *occidentale* S. Stokes. Two other forms of the species may eventually be found in Mohave Co., Arizona. The more likely of the two is var. *floccosum* Munz which is known from eastern San Bernardino Co., California, and southern Clark Co., Nevada. It differs from all Arizona forms in having the stems and branches densely floccose. The other form is var. *clokeyi* Reveal[1], a taxon now known only from northwestern Clark Co. and southern Nye Co., Nevada. It differs from all other forms of the species in having the involucres racemosely arranged along the branches, and in being a more open and spreading plant than is usually the situation. The following key will distinguish the three varieties of the species known to occur in Arizona.

KEY TO THE VARIETIES

A. Stems not sharply and deeply angled.
    B. Involucres ± racemosely arranged at the very tips of stout branches, the open branches strongly scabrous-papillate; local and rare, Coconino and Navajo cos. . . . . var. *subracemosum*

[1]*Eriogonum heermannii* Dur. & Hilg. var. *clokeyi* Reveal, var. nov. A var. *heermannii* et var. *humilium* involucris racemosis differt. -- TYPUS: Lee Canyon, 7 miles southwest of U.S. Highway 95, Spring Mountains, 5400 feet elevation, Clark Co., Nevada, 10 Aug 1966, *Holmgren & Reveal 2990*. Holotype, US. Isotypes, ARIZ, BRY, CAS, CS, DAO, DS, IDS, ISC, KSC, MO, NY, OKL, OSC, RENO, RSA, UC, UTC, WTU. This same variety was collected by Ira W. Clokey (*Clokey & Clausen 8682*) and is widely distributed in numerous herbaria.

BB. Involucres not racemosely arranged at the tips of the branches, or if so, then the branches slender, diffuse, scabrellous; Mohave and western Coconino cos . . . . var. *argense*

AA. Stems sharply and deeply angled, not smooth, the stems rigid yet slender; northern Mohave and Coconino cos . var. *sulcatum*

VAR. SUBRACEMOSUM (S. Stokes) Reveal. [*E. howellii* S. Stokes var. *s.* S. Stokes.] Low spreading subshrubs 3--6 dm high, 3--8 dm across; leaves lanceolate, 5--8 mm long, 1.5--2 mm wide, tomentose below, less so or more commonly glabrous above, ± revolute in some, the petioles 5--10 mm long; inflorescences open, composed of stout, heavy, often ± spine-tipped branches, 1--1.5 dm long, 1--2 dm wide, papillate-scabrellous throughout; involucres 1--1.5 mm long, 1.5--2 mm wide; flowers yellowish-white, 1.5--2 mm long. -- Restricted to limestone or more frequently sandstone ledges and outcrops in n. Coconino Co. and in n. Navajo Co., Ariz. Aug-Sep.

My inclusion of this taxon in Utah (Reveal 1973) was based on specimens of what now appear to be var. *argense*.

VAR. ARGENSE (M. E. Jones) Munz. [*E. sulcatum* S. Wats. var. *a.* M. E. Jones. *E. howellii* S. Stokes. *E. howellii* var. *a.* (M. E. Jones) S. Stokes.] Low spreading highly branched and divaricate shrubs 1--5 dm high, 2--6 (8) dm across; leaves linear to linear-lanceolate, 5--10 mm long, 1--3 mm wide, sparsely tomentose to glabrous below, glabrous above, the petiole 3--5 mm long; inflorescences congested and densely branched with numerous slender branches, 3--6 cm long, 5--15 cm across, scabrellous throughout; involucres 0.9--1.3 (1.5) mm long, 0.8--1.2 mm wide; flowers white, (1.5) 1.8--2.5 mm long. -- Locally common in widely scattered locations on limestone rock faces and outcrops from e. Calif. across s. Nev. to extreme sw. Utah, and nw. Ariz.; local and usually rare in n. Mohave Co. and in central Mohave and adjacent w. Coconino cos., Ariz. Jul-Oct.

In reading the description of *Eriogonum heermannii* in McDougall (1973), it would seem his account of the species is based on a mixture of this variant and the typical variant of California.

VAR. SULCATUM (S. Wats.) Munz & Reveal. [*E. s.* S. Wats. *E. h.* ssp. *s.* (S. Wats.) S. Stokes.] Low spreading highly branched and divaricate subshrubs (1) 1.5--3 (4) dm high, 1.5--6 dm across; leaves linear-lanceolate to elliptic or spatulate, 4--12 mm long, 2--5 mm wide, sparsely tomentose below, becoming glabrous at maturity, glabrous above, the petiole 3--5 mm long; inflorescences highly congested and densely branched with numerous slender but rigid branches, 1--3 (5) cm long, 3--10 cm wide, furrowed and angled as well as minutely scabrellous throughout; involucres 0.7--1.3 (1.5) mm long and wide; flowers yellowish-white, 1.5--2 mm long. -- Local and frequently common on limestone or rarely sandstone outcrops from se. Calif. across s. Nev. to sw. Utah, and nw. Ariz.; n. Mohave and Coconino cos., Ariz. Jul-Sep (Oct).

14. E. APACHENSE Reveal. Low rounded subshrubs 2--5 dm high, 3--6 dm across; leaves oblanceolate to elliptic, (5) 7--12 (15) mm long, 2--5 (6) mm wide, densely white-tomentose below, sparsely tomentose to floccose and green above, the margin flat, the petiole 1--5 mm long; stems slender, 0.5--2 cm long, glabrous and scabrellous; inflorescences cymose, 1--2 dm long, 1--2.5 dm wide, composed of several rather rigid and erect to spreading branches, glabrous and scabrellous throughout; involucres narrowly turbinate, 1--1.8 mm long, 0.7--1.3 mm wide, glabrous without, the 5 rounded teeth 0.3--0.5 mm long; flowers white with reddish or greenish midribs and bases, becoming reddish to rustic in age, (2.5) 3--4 mm long, glabrous, the tepals dimorphic, those of the outer whorl ovate, those of the inner whorl narrowly lanceolate; achenes light brown, 2.5--3 mm long. -- Local and often rare, known from nw. of Bylas, Graham Co. and s. of Vail, Pima Co., Ariz. Sep-Nov.

This species is closely related to *Eriogonum heermannii*, and the two differ only in a series of fine details, but in a substantial ecological and distributional manner. Since I described the species (Reveal 1969) I have learned that Marcus E. Jones collected the species south of Vail in Pima Co. I have been unable to relocate this collection site. In the type area, the plants are restricted to gypsum outcrops in scattered pinyon-juniper. In my opinion, the species is "threatened" due to its proximity to U.S. Highway 70.

15. E. PLUMATELLA Dur. & Hilg. [*E. palmeri* S. Wats. *E. nodosum* Small var. *jaegeri* Munz & Johnston. *E. plumatella* var. *j.* (Munz & Johnston) S. Stokes.] Open erect shrubs 3--6 dm high, 3--8 dm across, woody only at the base; leaves oblanceolate to oblong-lanceolate, 6--15 mm long, 2--4 mm wide, tomentose on both surfaces, the margin entire, the petiole 1--5 mm long; stems stout and usually short-persistent (2 years or less), tomentose or glabrous; inflorescences open, composed of horizontal branches with tiers arranged on one side of the main axis and forming masses of intricately divaricated branches, 1.5--4 dm long and wide, tomentose or glabrous; involucres turbinate, 2--2.5 mm long, 1.5--2 mm wide, glabrous without, the 5 acute teeth 0.5--0.8 mm long; flowers pale yellow to white with brownish-red to greenish midribs and bases, 2--2.5 mm long, glabrous, the tepals slightly dimorphic, obovate, those of the inner whorl slightly narrower; achenes light brown to brown, 2.5--3 mm long. -- Widespread and often locally common from s. Calif., s. Nev., w. Ariz., and possibly from sw. Utah; local and usually rare in w. Mohave Co., Ariz. Aug-Nov.

For years I have maintained var. *jaegeri* as distinct, more out of respect for the opinions of Philip A. Munz, who proposed the taxon, and Edmund C. Jaeger, the distinguished desert scientist, for whom it was named (Reveal & Munz 1968). Careful field work in southern California shown, however, that the character of the glabrous (var. *jaegeri*) versus tomentose (var. *plumatella*) stems just is not biologically significant, and the variety cannot be maintained.

16. E. THOMPSONAE S. Wats. Spreading herbaceous perennials 2--4 (6) dm high, 2--5 dm across; leaves oblong to oblanceolate or elliptic and (2) 3--4.5 (5) cm long, 8--15 mm wide, or linear and 3--8 (10) cm long, 2--4 (6) mm wide, thinly to densely white-tomentose below, usually glabrous and green above, infrequently glabrous on both surfaces, the margin entire, plane or slightly revolute to thickened, the petiole 3--7 cm long; stems erect, 5--25 cm long, glabrous; inflorescences open, cymose, (0.5) 1--3 dm long, glabrous and bright green; peduncles lacking; involucres turbinate, 2--4 mm long, 1--2 mm wide, glabrous, the 5 acute teeth 0.3--0.5 mm long; flowers yellow or white, 3--3.5 mm long, glabrous, the tepals oblong; achenes light brown to brown, 2.5--3 mm long. -- Local and often infrequent to rare in sandy-clay soils on the foothills and flats near the base of sandstone mesas, s. Utah and n. Ariz.; ne. Mohave Co., but to be expected in extreme nw. Coconino Co., Ariz. Jul-Nov.

The species is composed of three distinct and non-intergrading varieties, the two noted here and var. *albiflorum* Reveal of Washington Co., Utah. It differs from the white-flowered var. *atwoodii* in having elliptical leaves 8--15 mm wide. Var. *albiflorum* may be eventually discovered in the Colorado City area of Mohave Co., Arizona.

VAR. THOMPSONAE. Leaves oblong to oblanceolate or elliptic, (2) 3--4.5 (5) cm long, 8--15 mm wide, tomentose below, the margin flat; flowers yellow. -- Sandy-clay hills and flats in s. Utah and n. Ariz.; our few collection from extreme ne. Mohave Co. and to be expected near Fredonia, Coconino Co., Ariz.

Although this variety is known from several (three in Utah and three in Arizona) populations in Washington and Kane cos., Utah, and Mohave Co., Arizona, I have considered the plant "threatened" due to its proximity to highways in Arizona, the town of Kanab in Utah, and heavy recreationally-used areas such as Pipe Springs National Monument in Arizona, and Zion National Park in Utah (Nelson 1976).

VAR. ATWOODII Reveal. Leaves linear, 3--8 (10) cm long including the indistiguishable petiole, 2--4 (6) mm wide, thinly to moderately tomentose below, the margin inrolled or at least thickened; flowers white. -- Clay hills ca 4.5 mi w. of Fredonia in Mohave Co., Ariz. Jul-Oct.

The var. *atwoodii* is considered "endangered" because of its close proximity to Arizona Highway 389 and the heavy overgrazing associated with the Kaibab Indian Reservation; the taxon occurs in the same area as *Eriogonum mortonianum* and *Cryptantha subglabra* as already noted in the discussion of Morton's buckwheat. I would suggest that these low, clay hills west of Fredonia be considered "critical habitats" and protected.

In addition to the endangered nature of var. *atwoodii*, it is of considerable interest because it is clear that it is forming a series of hybrids and backcrosses with *Eriogonum mortonianum* judg-

ing by the glabrous nature of the linear leaves and the somewhat more open and spreading habit of scattered individuals. It will be of some importances to evolutionary biologists to witness this populational interaction between two unrelated taxa of the genus. Hybrids are generally rare in *Eriogonum* in nature, and almost always occur between distantly related species groups. This observation was noted when the type was collected in 1973, and studied again in the summer of 1976. It was not recorded previously, however (Reveal 1974b).

The reference to a shrubby form of *Eriogonum thompsonae* in my discussion of the Utah buckwheats (Reveal 1973) alluded to a small and distinctive population of plants near the western entrance to Zion National Park in Washington Co., Utah. I have observed these plants prior to anthesis on several occasions, and have finally concluded that they are better treated as a form of *E. corymbosum*, and are hereby named *E. corymbosum* var. *matthewsae*.[2]

17. E. GYPSOPHILUM Wooton & Standley. Small erect herbaceous perennial 1.2--2 dm high, 1--2 dm across; leaves cordate to truncate, (1) 1.5--2.5 cm long, 1.5--2.5 (3) cm wide, glabrous except for the margin and midvein, the petiole 3--5 cm long, finely strigose; stems erect, 8--10 cm long, glabrous except for a few minute hairs basally; inflorescences cymose, 4--10 cm long, 5--12 cm wide, glabrous; peduncles erect, 1--3 cm long, becoming shorter above, glabrous; involucres broadly campanulate, 1--1.5 mm long, 2--2.5 mm wide, glabrous, the 5 acute teeth 0.4--0.7 mm long; flowers yellow, 1--1.7 (2) mm long, finely white-pubescent along the midribs and bases without, the tepals lanceolate, those of the inner whorl slightly narrower; achenes light brown, 1.5--1.8 mm long. -- Local and rare on white, gravelly gypsum outcrops in the Seven River Hills sw. of Lakewood, Eddy Co., N.M.

This is one of the more "endangered" species of *Eriogonum*, and has been collected only three times to my knowledge: The type which was gathered by Wooton in 1909, a Barneby collection (*Barneby 14464*), and a collection of my own (*Reveal 2949*). All specimens have come from the same area in the Seven River Hills, and a portion of the population has been destroyed by the construction of U.S. Highway 285. If and when that highway is increased to 4 lanes as it has been elsewhere, considerable care will have to be made

[2] *Eriogonum corymbosum* Benth. in DC. var. *matthewsae* Reveal, var. nov. A var. *corymboso* foliis late ellitpticis 2--3 cm longis et 1--1.5 cm latis cum dense lanis subter, caulibus glabris, involucris turbinatis 2--3 mm longis differt. -- TYPUS: On purplish siltstone west of Utah Highway 15, 0.3 mile south of Sprindale near the west entrance to Zion National Park, Washington Co., Utah, 4 Oct 1969, *Welsh, Shaw, Matthews & Moore 9509*. Holotype, MARY. Isotypes, BRY, UMO, US. The variety is named for M. Eileen Matthews, formerly a graduate student at Brigham Young University who studied the *Gilia latifolia* S. Wats. complex for her Master's Thesis, and an enthusiastic field botanist.

to prevent the total destruction of the species.

The original publication of the species was presented by Wooton and Standley in 1913.

18. E. BRANDEGEI Rydb. [*E. spathulatum* A. Gray var. *b.* (A. Gray) S. Stokes.] Low spreading herbaceous perennial 1--2.5 dm high, 1--2 dm across; leaves oblanceolate to elliptic, 1.5--3 (4) cm long, 4--8 mm wide, tomentose on both surfaces, the margin entire and plane, the petiole 1--1.5 cm long; stems erect, 1--2.5 dm long, tomentose to floccose; inflorescences capitate or nearly so; peduncles lacking or up to 3 mm long, thinly floccose to glabrous; involucres congested, 4--8 per head, turbinate, 3.5--5 mm long, 3--4 mm wide, floccose to glabrous, the 5 acute teeth 0.4--1 mm long; flowers white, 3--3.5 mm long, glabrous, the tepals oblanceolate to oblong; achenes brown, 3--3.5 mm long. -- Local and rare in central Colo. and reportedly from n. N.M. Aug-Sep.

I am including this species in the New Mexico flora on the basis of a single, undated collection made by Edward L. Greene which is deposited at ISC and states only "northern New Mexico." I have other specimens from Chaffee and Fremont cos., Colorado, and a Letterman collection (MO) supposedly from Colorado Springs in El Paso Co., Colorado. I am highly suspicious of the location data on both the Greene and Letterman collections. Due to the rareness of this species, I am considering it "threatened".

19. E. LONCHOPHYLLUM Torr. & Gray. Spreading herbaceous perennial 1--4 dm high, 1--6 (8) dm across; leaves sheathing up the stem (1) 2--5 (8) cm, linear to linear-oblong or linear-spatulate, lanceolate to narrowly oblanceolate, 2--15 (20) cm long, 2--12 mm wide, tomentose below, floccose to glabrous above, the margin entire or crenulate, plane or revolute, the petiole 5--18 (25) mm long, glabrous to tomentose; stems erect or nearly so, 5--15 (20) cm long, glabrous or rarely floccose (in Colorado); inflorescences cymose, 5--15 (20) cm long, 4--10 cm wide, glabrous; peduncles, when present, up to 3 cm long, erect, glabrous; involucres turbinate, 2--4 mm long, 2--3 mm wide, glabrous, 5-toothed; flowers white with greenish or reddish midribs and bases, (2) 2.5--4 mm long, glabrous, the tepals oblong to obovate; achenes light brown to brown, 3--3.5 mm long. -- Widespread and highly variable in rocky to gravelly places or on clay hills and flats, or in mesic places on the forest floor from w. and s. Colo. s. to n. N.M.; from w. Rio Arriba Co. s. to Sandoval Co. e. to Santa Fe Co., N.M. Jun-Sep.

This species, as now defined, is highly variable and composed of several minor variants, some of which may deserve special recognition. I am proposing one here, var. *nudicaule*, for a series of small plants restricted to the southernmost fringe of the species' range. However, within Colorado are several phases that are much more difficult to resolve, and none is attempted here.

VAR. LONCHOPHYLLUM. [*E. salicinum* Greene. *E. scoparium* Small. *E. tristichum* Small. *E. sarothriforme* Gand. *E. effusum* Nutt. ssp.

salicinum (Greene) S. Stokes. *E. nudicaule* (Torr.) Small ssp. *scoparium* (Small) S. Stokes. *E. n.* ssp. *t.* (Small) S. Stokes.] Spreading herbs 1--4 dm high, 1.5--6 (8) dm across; leaves sheathing up the stems 2--8 cm long, the leaf-blades linear to linear-oblong or linear-spatulate, lanceolate to narrowly oblanceolate, 2--15 (20) cm long, 2--12 mm wide; inflorescences cymose, 5--15 (20) cm long, divided 3--5 or more times; involucres 2--4 mm long; flowers white to creamish-white. -- Local and occasionally common from w. and s. Colo. s. to n. N.M.; mainly in pine forest in mesic sites in n. Rio Arriba Co., N.M. Jun-Sep.

The leaves of the New Mexico plants are not nearly as variable as those found in the Colorado plants, as they tend to be on the linear side of the spectrum. However, in extreme northern Rio Arriba Co., south of Chromo, Colorado, the leaves are lanceolate as in the type of the species which was gathered along the White River south of Pagosa Springs.

VAR. NUDICAULE (Torr.) Reveal, comb. nov., based on *E. effusum* Nutt. var. *nudicaule* Torr., Explor. & Surv. Railroad Route from Mississippi River to Pacific Ocean 4: 132. 1857. [*E. n.* (Torr.) Small.] Erect herbs 2--3 dm high, 1--2 dm across; leaves basal or sheathing up the stem less than 2 cm, the leaf-blades linear to linear-lanceolate, 3--5 (7) cm long, 2--4 mm wide; inflorescences cymose, 5--12 cm long, divided 1--3 times; involucres 2--3 mm long; flowers white. -- Local and rather rare on clay hills and flats in Sandoval and Santa Fe cos., N.M. Aug-Sep.

In Stokes' (1936) monograph of the genus, she failed to understand the nature of the type of *E. effusum* var. *nudicaule* in that she associated several discordant elements with the species name, *E. nudicaule*. Although she recognized the general similarities of the species to *E. scoparium* and *E. tristichum*, both synonyms of var. *lonchophyllum*, she also associated forms of *E. brevicaule* with the species, naming *E. brevicaule* var. *brevicaule* and var. *laxifolium* (Torr. & Gray) Reveal, and a second species, *E. spathulatum* A. Gray. She retained *E. lonchophyllum* as a valid species, but referred *E. salicinum* to *E. effusum*, and *E. sarothriforme* to what I have called *E. corymbosum*.

The new variety of *Eriogonum lonchophyllum* differs from var. *lonchophyllum* mainly in its open, erect habit that is decidedly not shrublike, the nearly basal leaves, and less branched inflorescences.

20. E. LACHNOGYNUM Torr. ex Benth. in DC. [*E. tetraneuris* Small. *E. l.* ssp. *t.* (Small) S. Stokes.] Erect herbaceous perennials 1--3.5 dm high, 1--2 dm across; leaves lanceolate to narrowly elliptic, 1--2.5 (3) cm long, 3--5 (8) mm wide, white- or silvery-tomentose on both surfaces or sometimes somewhat less so above, the petiole 0.5--2.5 (3) cm long; stems erect, 1--2 dm long, floccose; inflorescences subcapitate to cymose, floccose; peduncles erect, 2--15 mm long, floccose; involucres broadly campanulate, 3--4 mm long, 3--6 mm wide, floccose without, the 5

broadly acute to obtuse teeth 1--1.5 mm long; flowers yellow under the dense, white pubescent without, 2.5--5 (6) mm long, the tepals lanceolate; achenes brown, 3--4 mm long, villous throughout. -- Local and rare to infrequent on limestone outcrops, flats, and gypsum slopes from s. Colo. and sw. Kans. s. to n. Tex., n. N.M., and nw. Ariz.; usually but not always associated with gypsum soils from Apache Co., Ariz., and across the n. third of N.M. Jul-Oct.

21. E. HAVARDII S. Wats. [*E. leucophyllum* Wooton & Standley] Erect herbaceous perennials (2) 3--6 dm high, 1.5--4 dm across; leaves oblanceolate to elliptic, 1--3 (5) cm long, 2--10 (13) mm wide, white- or silvery-tomentose on both surfaces, the petiole 5--15 (25) mm long; stems erect, 5--25 cm long, glabrous; inflorescences cymose, 1--4 dm long, glabrous; peduncles erect, 0.5--6 cm long, glabrous; involucres campanulate, 1.5--2.5 mm long, (1.5) 2--3 mm wide, glabrous, the 5 acute teeth 0.5--0.8 mm long; flowers yellow under the dense white pubescence, 2.5--3 mm long, the tepals lanceolate; achenes brown, 2--2.5 mm long, glabrous. -- Local and usually rare or at least infrequent on gravelly to rock limestone outcrops in se. N.M. and w. Tex.; Socorro, Lincoln, and Chaves cos. s. to the Tex. line. May-Sep.

This tall, graceful species is frequently not seen even when in flower due to the slender stems and branches, and the basal leaves. The species is unique in the New Mexico flora and cannot be confused. The type of *Eriogonum leucophyllum* described by Wooton and Standley (1913) has no real bases, and Stokes (1936) totally misunderstood the nature of the type (see *E. hieracifolium*).

22. E. WRIGHTII Torr. ex Benth. in DC. Low spreading highly branches subshrubs or shrubs 1.5--15 dm high, 1--15 dm across; leaves sheathing, the leaf-blades linear to oblanceolate or elliptic to broadly elliptic, (0.3) 0.5--3 cm long, 1--25 mm wide, tomentose on both surfaces or with the upper surface floccose to glabrous and green, the margin entire or crenulate, plane to revolute, the petiole 0.2--5 (6) mm long; stems slender to stout, 5--40 (60) cm long, lanate to glabrous; inflorescences virgate to ± cymose or rarely capitate, the involucres usually racemosely arranged along the tips (at least) of the branches, up to 4 dm long, lanate to glabrous; peduncles lacking; involucres turbinate to turbinate-campanulate, 1--4 mm long, 1--2.5 mm wide, lanate to glabrous, the 5 acute to rounded teeth 0.3--1 mm long; flowers white, becoming pink to rose, 1.5--4 mm long, glabrous, the tepals obovate to oblong-obovate; achenes light brown to brown, (1) 1.5--3 mm long. -- Widespread and highly variable from n. Calif. to central Baja Calif., e. across s. Nev. to n. Ariz., and se. across most of Ariz. and s. N.M. to w. Tex. s. into central Mex. Jul-Dec.

This species is highly variable, ranging from tiny cespitose mats atop the Sierra Nevada [var. *olanchense* (J. T. Howell) Reveal] to large desert shrubs such as var. *nodosum* (Small) Reveal. The Arizona and New Mexico plants belong to only two of the eleven varieties belong to the species.

VAR. WRIGHTII. [*E. w.* var. *floccosum* Benth. in DC. *E. helianthemifolium* Benth. in DC. *E. w.* var. *h.* (Benth. in DC.) Torr. in Emory. *E. trachygonum* Torr. ex Benth. in DC. ssp. *w.* (Benth. in DC.) S. Stokes. *E. t.* ssp. *glomerulum* S. Stokes. *E. w.* ssp. *g.* (S. Stokes) S. Stokes.] Low subshrubs 1.5--5 dm high, 1--5 dm across; leaves oblanceolate to elliptic, 0.5--1.5 cm long, 2--5 (7) mm wide, tomentose below, floccose above, the petiole up to 5 mm long; inflorescences slender to ± stout, tomentose to floccose throughout; involucres turbinate, 2--2.5 mm long; flowers white, becoming pink to rose in some, 2.5--4.5 mm long; achenes 2.5--3 mm long. -- Common and widespread from e. Calif. e. across Ariz. and N.M. to w. Tex., and s. to central Mex.; common throughout all but the ne. quarter of N.M. July-Sep.

VAR. PRINGLEI (Coulter & Fisher) Reveal. [*E. p.* Coulter & Fisher. *E. trachygonum* Torr. ex Benth. in DC. ssp. *p.* (Coulter & Fisher) S. Stokes. *E. w.* ssp. *p.* (Coulter & Fisher) S. Stokes.] Spreading shrubs 3--7 dm high, 4--10 dm across; leaves broadly elliptic, 7--15 mm long, 2--5 mm wide, lanate on both surfaces, the petiole 1--3 mm long; inflorescences dense, stout, lanate; involucres turbinate-campanulate, 1--1.5 mm long; flowers white, becoming pink to rose, 1.5--1.8 mm long; achenes 1--1.5 mm long. -- Local and rare in s.-central and sw. Ariz., from Yuma, Pinal, and Pima cos. Aug-Nov.

I have not observed this taxon in the field, and I know little about its overall distribution other than it is rare and infrequently collected. It is possible, with field studies, this variant may well have to be proposed as endangered or threatened.

23. E. RACEMOSUM Nutt. [*E. orthocladon* Torr. in Sitgr. *E. obtusum* Benth. in DC. *E. r.* var. *sagittatum* Gandoger. *E. r.* var. *cordifolium* Gandoger. *E. r.* var. *orthocladon* (Torr. in Sitgr.) S. Stokes. *E. r.* var. *obtusum* (Benth. in DC.) S. Stokes.] Tall erect herbaceous perennials 3--8 (10) dm high; leaves elliptic to ovate or oval, (1.5) 2--6 (10) cm long, 1--2.5 (3.5) cm wide, lanate to tomentose below, floccose to glabrate or glabrous above, the petiole (2) 3--10 (15) cm long; stems erect, (1) 1.5--2.5 (3) dm long, tomentose to floccose; inflorescences cymosely branches with the virgated branches bearing 5--20 or more racemosely arranged involucres, 1.5--5 dm long, divided (2) 3--7 (10) times, tomentose to floccose; peduncles, when present, erect and up to 4 cm long, tomentose to floccose; involucres turbinate-campanulate, (2) 3--5 mm long, (2) 2.5--4 mm wide, tomentose to floccose without, the 5 acute teeth 0.1--0.5 mm long; flowers white to greenish- or brownish-white with greenish or reddish midribs and bases, often becoming pink to rose in fruit, (2) 2.5--5 mm long, glabrous, the tepals oblong-oblanceolate; achenes light brown, 3--4 mm long. -- Common and widespread from central Nev. e. across Utah to s. Colo, n. Ariz., and n. N.M.; usually on the forest floor or on sagebrush flats from Mohave Co. e. to Apache Co. and s. to Gila Co., Ariz., and from San Juan Co. e. to Colfax Co., and s. to Catron Co., N.M.

None of the variants recognized in this species is particularly distinct, and the continued attempt to recognize leaf-shape determined varieties is unnecessary.

24. E. ZIONIS J. T. Howell var. COCCINEUM J. T. Howell. Erect herbaceous perennials 3--5 dm high; leaves oblong-ovate to ovate, 2--4.5 cm long, 1.5--2.5 (3) cm wide, lanate to tomentose below, thinly floccose to glabrous above, the petiole 3--6 (8) cm long; stems erect, 1--2.5 dm long, slender or slightly fistulose, glabrous and grayish-green; inflorescences narrow, cymosely branched with the virgated branches containing 8--15 racemosely arranged involucres, 2--3.5 dm long, divided 2--5 times, glabrous; involucres turbinate to turbinate-campanulate, 1.5--3 mm long, 1.5--2.5 mm wide, tomentose without, the 5 rounded teeth 0.2--0.4 mm long; flowers brilliant red or scarlet, 2.5--3.5 (4) mm long, glabrous, the tepals oblong; achenes light brown, 3--4 mm long. -- Local and exceedingly rare, known from only a few individuals at Point Sublime (n. rim of the Grand Canyon) and at the head of Bass Trail at Bass Camp (s. rim of the Grand Canyon), Coconino Co., Ariz. Aug--Sep.

This is one of Arizona's most endangered taxa. On the South Rim, about 15 individuals were known in 1939 when the last census (to my knowledge) was taken. At Point Sublime, I discovered the real population of var. *coccineum* as short distance to the northwest of where the type collection was made (Howell 1943). Here there were more than 50 individuals all within an area of less than an acre. Although this taxon occurs within a national park, the heavy recreational use of Grand Canyon National Park does not readily lend itself for a prior protection of such a rare plant.

I reported in my review of the Utah buckwheats (Reveal 1973) that var. *zionis* may have been collected near Flagstaff. The basis of that report is *Mishler 1215*, along Lake Mary, 11 Jul 1967 (ASU, BRY). I have been unable to visit this area and investigate the population, but I tend to think that this may be a rare, glabrous individual of *E. racemosum*.

25. E. SHOCKLEYI S. Wats. var. LONGILOBUM (M. E. Jones) Reveal. [*E. l.* M. E. Jones. *E. acaule* Nutt. var. *l.* (M. E. Jones) M. E. Jones. *E. s.* ssp. *l.* (M. E. Jones) S. Stokes.] Low pulvinate herbaceous perennials forming flat to rounded mats (1) 2--4 dm across; leaves oblanceolate to spatulate, (3) 5--8 (12) mm long, (2) 3--6 mm wide, tomentose below, often slightly less so above, the petiole 2--5 mm long; stems scapose, up to 3 cm long, tomentose, erect or nearly so; inflorecences capitate; involucres congested, campanulate, (3) 4--6 mm long, floccose to tomentose without, the 5--10 lanceolate lobes (1) 2--3 mm long; flowers white with reddish to rustic midribs and bases, becoming rose to rustic in age, 3--4 mm long, the tepals oblong to obovate; achenes light brown to brown, 2.5--3 mm long, usually densely pubescent. -- Clay hills and flats or infrequently on sandstone ledges and outcrops from (as a species) e. Calif. e. to s. Ida., w. Colo. and nw. N.M.;

extreme e. Mohave Co. e. across the n. tier of cos. in Ariz. to San Juan Co., N.M. May-Jul (Sep).

This species is composed of two additional variants, one of which from southwestern Idaho is still undescribed. The typical variety occurs from eastern California across most of Nevada to western Utah and southern (mainly eastern) Idaho. The var. *longlobum*, on the other hand, occurs from eastern Utah and adjacent western Colorado southward to Arizona and New Mexico.

26. E. OVALIFOLIUM Nutt. Low matted pulvinate to cespitose herbaceous perennials forming mats (0.5) 1--4 dm across; leaves oblanceolate to elliptic or spatulate, oblong to obovate or oval to rounded, 0.2--6 cm long, (1) 2--15 mm wide, tomentose on both surfaces or somewhat less so above, the petiole up to 1 dm long; stems scapose, 0.3--30 cm long, lanate to floccose; inflorescences capitate; involucres solitary or congested (ours), turbinate to turbinate-campanulate, (2) 3.5--5 (6.5) mm long, 2--4 mm wide, tomentose to floccose without, the 5 acute to rounded teeth up to 1 mm long; flowers white, cream or brownish maturing pinkish, rose, red, or purple, or yellowish to yellow, (2.5) 3--6 (7) mm long, glabrous, the tepals dimorphic, those of the outer whorl oval to orbicular, those of the inner whorl lanceolate to elliptic and somewhat longer; achenes light brown to brown, 2--3 mm long. -- Widespread and common throughout much of the western United States and southern Canada; Mohave Co. e. across the n. tier of cos. in Ariz. to San Juan Co., N.M. Apr-Jul.

This species is exceedingly complex and difficult due to the numerous minor, and major, morphological variations which have received formal taxonomic recognition. McDougall (1973) proposed to treat the white-flowered phase of the species, as it occurs in the two states being considered here, as ssp. *vimeum* (Small) S. Stokes. However, as we (Reveal & Munz 1968) have shown previously, the var. *vimeum* (Small) A. Nels. is restricted to a few limestone outcrops in the San Bernardino Mountains in California (where it is now seriously endangered). Munz and Keck (1959) termed the white-flowered form in Califorina ssp. *eximium* (Tidestrom) S. Stokes, but this name was later placed in synonymy under var. *nivale* (Canby) M. E. Jones (Reveal & Munz 1968). Recently, Howell (1976) has proposed to restrict var. *eximium* (Tidestrom) J. T. Howell to the Carson Range in western Nevada and adjacent California, and differentiated it from var. *nivale* on the basis of involucres and flower size, and from var. *ovalifolium* on scape length and the degree of division of the involucral teeth. The var. *eximium* is a low elevation form of var. *nivale*, and little more.

The yellow-flowered form of the species has been called a series of names, but the oldest available variatal name in var. *multiscapum* Gandoger. I have not seen this variant from Arizona, but McDougall (1973) claims the yellow-flowered phase to be present. The above description applies to all forms of the species, and below I shall present a series of distinction to separate var. *ovalifolium* from var. *multiscapum*, although the distribution of the

latter cannot be given.

VAR. OVALIFOLIUM. [*Eucycla o.* (Nutt.) Nutt. *Eucycla purpurea* Nutt. *Eriogonum p.* (Nutt.) Benth. in DC. *Eriogonum o.* var. *p.* (Nutt.) Durand. *Eriogonum o.* ssp. *p.* (Nutt.) S. Stokes.] Mats 2.5--4 dm across; leaves mostly obovate to oval or rounded, 0.5--2 cm long, the petiole (3) 5--15 mm long; flowers white to cream or brownish, maturing pinkish to rose or purplish, 4--5 mm long. -- Common throughout the w. United States and sw. Canada; across the n. tier of cos. in Ariz. and into San Juan Co., N.M. Apr-Jul.

VAR. MULTISCAPUM Gandoger. [*E. orthocaulon* Small. *E. ovalifolium* var. *celsum* A. Nels. *E. ovalifolium* var. *orthocaulon* (Small) C. L. Hitchc.] Mats 2--4 dm across; leaves elliptic to spatulate or oblong, 3--6 cm long, the petiole 3--8 (10) cm long; flowers pale-yellow to yellow, 4--7 mm long. -- Rather common from sw. Wyo. and w. Colo. across n. Utah and Nev. to e. Calif., and in s. Ida. and se. Ore.; reportedly in n. Ariz. according to McDougall (1973), but no specimens seen by this writer. Apr-Jun.

SUBGENUS MICRANTHA (BENTH.) REVEAL

27. E. ANNUUM Nutt. [*E. lindheimerianum* Scheele. *E. simpsonii* Benth. in DC. var. *floccoso-lanatum* Benth. in DC. *E. cymosum* Benth. *E. a.* ssp. *c.* (Benth. in DC.) S. Stokes. *E. a.* ssp. *chihuahuaense* S. Stokes.] Tall leafy biennial or infrequently late-flowering annual herbs 0.5--2 m high; leaves oblong to oblanceolate, 1--7 cm long, 3--15 mm wide, tomentose below, floccose above, the petiole mostly less than 5 mm long; stems erect, 0.4--1 m long, leafy, floccose to tomentose; inflorescences mostly cymose and open, up to 1 m long but mostly (1) 2--7 dm long, floccose to tomentose; peduncles, when present, erect, up to 5 mm long, mostly tomentose; involucres turbinate to campanulate, 2.5--4 mm long, 2--3 mm wide, floccose to tomentose without, the 5 acute to triangular teeth 0.4--1 mm long; flowers white to pink maturing rose to red-brown, 1--2.5 mm long, glabrous without, pubescent and glandular within, the tepals dimorphic, those of the outer whorl obovate, those of the inner whorl narrowly ovate to oblong; achenes brown, 1.5--2 mm long or sometimes becoming tangled in the pubescence of the flower and seemingly pubescent. -- Great Plains of the United States s. to ne. Mex.; widespread and rather common in the e. half of N.M. from Rio Arriba and Balencia cos. s. to Dona Aña Co., and then e. (Apr) Jun-Sep (Nov).

This species is the only member of the genus that is a tall, densely tomentose, leafy plant with the exception of *Eriogonum polycladon* Benth. in DC. The latter has very small flowers that are glabrous, usually solitary leaves (not in fascicles as in *E. annuum*), and a much branched, elongated inflorescence of racemosely arranged involucres. The related *E. multiflorum* Benth. may eventually be found in New Mexico (see Reveal 1970).

SUBGENUS OLIGOGONUM NUTT.

28. E. UMBELLATUM Torr. Low cespitose to pulvinate herbaceous perennials to erect or spreading subshrubs or shurbs up to 1 m high and across, the mats, when formed, up to 8 dm across; leaves oblong, elliptic, oval, spatulate, broadly obovate to suborbicular, 0.4--3 cm long and wide, densely lanate to tomentose or glabrous on both surfaces, or more frequently tomentose below and subglabrous to glabrous and green above, the petiole 0.2--10 mm long; stems slender to stout, (3) 5--30 cm long, bractless about midlength, mostly tomentose to glabrous; inflorescences simple to compound umbels or reduced and subcapitate to capitate, the rays usually floccose to glabrous, up to 7 mm long; involucres turbinate to campanulate, the tube 1--6 mm long, (1) 1.5--10 mm wide, thinly tomentose to slightly floccose or glabrous without, the (5) 6--10 (12) linear-lanceolate to oblong lobes 1--6 mm long, usually reflexed; flowers cream to yellow, variable in coloration, 2.5--10 mm long including the (0.7) 1.3--2 mm long stipe, glabrous, the tepals slightly dimorphic, mainly spatulate to obovate; achenes light brown to brown, 2--5 mm long, sparsely pubescent at the apex. -- Widespread and common throughout most of the w. United States and sw. Can. May-Oct.

This species is highly variable and composed of more than 20 distinct variants. The species reaches its southernmost range in Arizona and New Mexico, and thus only a few members of the species are encountered here.

VAR. UMBELLATUM. Low mat-forming perennials up to 6 dm across; leaves tomentose below, glabrous to floccose (or rarely tomentose) above; stems up to 3 dm long; inflorescences umbellate and simple, not branched; flowers bright yellow, 4--7 mm long. -- Wash. e. to Mont. s. to central Oreg., n. Nev., nw. Ariz., and s. Colo.; known in our area only from a single collection (*Holmgren 3292*) from Wolf Hole Mtn., Mohave Co., Ariz., but to be expected in the mts. of n. N.M. Jun-Sep.

VAR. SUBARIDUM S. Stokes. [*E. biumbellatum* Rydb. *E. ferrissii* A. Nels. *E. u.* ssp. *f.* (A. Nels.) S. Stokes. *E. u.* ssp. *s.* (S. Stokes) Munz.] Erect to suberect subshrubby to shrubby perennials up to 6 dm across and 1 m high; leaves thinly floccose to glabrous on both surfaces; stems 0.5--2 dm long; inflorescences compoundly branches into two or more umbellate segments; flowers bright yellow or rarely cream-colored, 6--7 mm long. -- Restricted to the desert ranges from se. Calif. e. across s. Nev. to s. Utah, n. Ariz., and sw. Colo.; from Mohave Co. e. to nw. Navajo Co., Ariz. Jul-Oct.

McDougall (1973) includes within his description of *Eriogonum umbellatum* some features of var. *subaridum*, but aside from the length of the flowers and the distribution given, the description is based almost entirely upon var. *cognatum*. He implies, by the distribution listed, that what I am calling var. *subaridum* would be in

Apache Co., and while I have seen no specimens from this area, its presence would not be surprising (Reveal 1968d); I would also suspect the variant to be found in San Juan Co., New Mexico, as well. In Kearney and Peebles (1951), this plant was called simply *E. umbellatum*, but the type of *E. ferrissii* was referred to *E. cognatum*.

VAR. COGNATUM (Greene) Reveal. [*E. c.* Greene.] Low perennials to 3 (4) dm across; leaves densely white-tomentose below, thinly pubescent or more commonly glabrous and bright green above; stems erect, slender, 1--1.5 dm long, glabrous; inflorescences compoundly umbellate into several segments; flowers bright yellow, 4--6 mm long. -- Locally common in s.-central Coconino Co. s. to extreme ne. Yavapai and nw. Gila cos., Ariz. Jul-Sep.

The best distinction between var. *cognatum* and var. *subaridum* which can be noted in herbarium material is in the shape of the leaves. In the former, the leaves are oblong-obovate to broadly elliptic, while in the latter they are much narrower. In my note on this variant (Reveal 1968d), I pointed out the strongly isolated nature of var. *cognatum*, and concentrated field work in northern Arizona since then has done nothing to close the geographical gap between this taxon and the remaining members of the species.

29. E. CAESPITOSUM Nutt. [*E. andinum* Nutt.] Low pulvinate to cespitose herbaceous perennials forming mats up to 4 dm across; leaves elliptic to obovate or oblong-spatulate to nearly oval, 2--10 (15) mm long, 1.5--4 (5) mm wide, tomentose on both surfaces to slightly less so to floccose above, the petiole 0.5--4 mm long; stems scapose, ± erect, (1) 3--8 (10) cm long, usually floccose to glabrous, without a whorl of bracts even at the base of the involucre; inflorescences capitate; involucres campanulate, the tube 2--3.5 mm long, 3--5 mm wide, tomentose to floccose without, the 6--9 reflexed lobes 2--3.5 mm long; flowers yellow, becoming tinged with red or reddish with age, 2.5--10 mm long including the 0.5--1 mm long stipe, pilose to villous without, the tepals ± oblong to oblanceolate; achenes light brown to brown, (3.5) 4--5 mm long, with a glabrous to slightly pubescent beak. -- Widespread and locally infrequent to common from e. Calif. and Ore. e. to w. Mont., w. Wyo., and nw. Colo. s. to s. Utah and nw. Ariz.; known only from Beaver Dam Mtn., Mohave Co. Ariz. Apr-Jun.

Although this plant was collected by Barkley (*3360*, MONTU, WTU) in 1932, the species has not been reported from Arizona by either Kearney and Peebles (1951) nor McDougall (1973). It is obviously rare in the area as Higgins (1967) does not report the species from the Beaver Dam Mountains in Utah.

30. E. JAMESII Benth. in DC. Low matted to robust and erect herbaceous perennials up to 4.5 dm high and 6 dm across; leaves oblanceolate to elliptic, (0.5) 1--5 cm long, 0.5--2.5 cm wide, tomentose below, floccose above or becoming thinly pubescent to glabrous and greenish above in some, the petiole 0.5--6 cm long; stems erect, slender to stoutish, (3) 5--20 (25) cm long, tomentose to

floccose; inflorescences usually open, simple or compoundly umbellate, rarely highly reduced and capitate (as on the Kaibab Plateau, Ariz.), up to 3 dm long, tomentose to floccose; involucres turbinate to campanulate, 3--7 mm long, 2.5--8 mm wide, tomentose to floccose without, the 5--8 erect teeth up to 0.5 mm long; flowers white to cream or yellow with greenish to dark yellow midribs and bases, becoming tinged with pink in some at maturity, 3--9 mm long including the 0.7--2 mm long stipe, densely pubescent without especially along the midribs and bases, the tepals dimorphic, those of the outer whorl lanceolate, those of the inner whorl narrower and longer; achenes light brown to brown, 4--5 mm long, with a sparsely pubescent beak. -- Rather common and often locally abundant from e. Utah, Colo. and se. Wyo. s. to Ariz., N.M., w. Kans., w. and n. Tex., and ne. Mex.; common throughout much of both states but in particular n. and e. Ariz., and e. and s. N.M. Jun-Oct.

As I have become more and more familiar with *Eriogonum jamesii* the more I have come to discover that it is an exceedingly complex taxon with numerous local and region modifications in its gross external morphology. In the past I have tended to ignore the significance of many of these local populations, while in the related *E. umbellatum*, I (and others) have tended to recognize them. It is now becoming clear that *E. jamesii* is as difficult to treat as *E. umbellatum*. I have tried to maintain a uniform understanding of *E. umbellatum*, acknowledging that small, local populations are often very distinct (especially to the local flora expert), but when considered on the whole, none can be maintained at the species rank. Thus, Colorado workers (Weber, 1972) have kept *E. umbellatum* var. *majus* Hook. a distinct species (calling it *E. subalpinum* Greene), and Howell (1973, 1976) has proposed var. *torreyanum* (Gray in Torr. & Gray) M. E. Jones be considered as a distinct species. This does not take into account, for example, that in Wyoming, western Montana, and Idaho, var. *majus* intergrades with var. *dichrocephalum* Gandoger, nor that in extreme northern California and adjacent Oregon there is var. *glaberrimum* (Gandoger) Reveal which is as distinct from var. *umbellatum* as var. *torreyanum*, but together, are very close to one another.

The situation within *Eriogonum jamesii* is nearly as complex, but fortunately, with far few taxa than in *E. umbellatum*. However, unlike the latter species, associated with the former are a series of closely related species which are seemingly weakly distinct on biological grounds, but morphologically and distributionally, seem to be as sound a species as any in the genus. *Eriogonum correllii* Reveal of northern Texas, and *E. allenii* S. Wats. in Coult. & Wats. of the Virginias are highly isolated, but are still very closely related to *E. jamesii* var. *wootonii* Reveal of south-central New Mexico. Field studies have shown that in southeastern Wyoming and in extreme north-central Colorado, *E. jamesii* and *E. flavum* Nutt. in Fras. intergrade to such a degree that in the mountains east of Laramie, Wyoming, the two can often be exceedingly difficult to separate. This is one of the few cases in the genus where two related species intergrade; most hybridization is between unrelated

groups of species (*E. brevicaule* x *E. corymbosum*; *E. batemanii* x *E. shockleyi*; *E. brevicaule* x *E. microthecum*). While reviewing this situation in the field, I finally realized that a form of *E. flavum* in the Colorado Rocky Mountains, var. *xanthum* (Small) S. Stokes, was in fact not a form of *E. flavum*, but should be called *E. jamesii* var. *xanthum*.[3]

Finally, discussion with Steve Stephens and Ronald McGregor of the University of Kansas, coupled with my own field work in southwestern Kansas, have proved to me that the isolated Kansas populations deserve special recognition as proposed by Gandoger (1906), and thus *Eriogonum jamesii* var. *simplex* Gandoger is maintained for these plants.

VAR. FLAVESCENS S. Wats. [*E. arcuatum* Greene. *E. bakeri* Greene. *E. vegetius* A. Nels. *E. j.* ssp. *f.* (S. Wats.) S. Stokes. *E. j.* var. *a.* (Greene) S. Stokes. *E. j.* ssp. *b.* (Greene) S. Stokes.] Mats up to 5 dm across; leaves oblanceolate to elliptic, 1--3 cm long, 0.5--1.5 cm wide, the margin entire; inflorescences divided 1--3 times, up to 2 dm long, rarely capitate or umbellate as in northern Arizona; bracts mostly narrowly elliptic, up to 2 cm long and 1 cm wide; involucres 3--7 mm long, 4--8 mm wide; flowers yellow, (4) 5--8 mm long. -- Common and rather widespread from e. and s. Utah e. to s. and central Colo. as far n. as se. Wyo., and s. to n. Ariz and N.M.; local and often common from Mohave Co. e. across the n. tier of cos. (and Yavapai Co.) to nw. N.M. (as far e. as Sandoval Co.). Jul-Sep.

The attempts to maintain either *Eriogonum arcuatum* or *E. bakeri* as distinct from *E. jamesii* simply do not take into account the variation within *E. jamesii*. The only major difference between vars. *flavescens*, *rupricola* Reveal (of southwestern Utah), *wootonii*, and the forms more closely related to var. *jamesii* such as vars. *simplex* and *undulatum* is the flower color. Again this is an impressive difference to the local taxonomist, but not so when the entire range of the species is considered, and when one remembers that in such species as *E. umbellatum* and *E. compositum* Dougl. ex Benth. in Lindl. both color phases are common.

VAR. WOOTONII Reveal. Mats up to 5 dm across; leaves broadly elliptic, 3--5 cm long, 1.5--3 cm wide, the margin entire; inflorescences divided 3--5 times, up to 2 dm long; bracts mostly foliaceous, those of the first node narrowly elliptic, 2--4 cm long, 0.7--1.8 cm wide; involucres 3--6 mm long, 4--9 mm wide; flowers yellow, 4--7 (9) mm long. -- Local and often common in the mts. of s.-central N.M. in Lincoln and Otero cos. Jul-Sep (Oct).

This New Mexico phase was described in my 1973 paper on the buckwheats of Utah. It has been variously called *E. jamesii* or *E. bakeri*.

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[3] *Eriogonum jamesii* Benth. in DC. var. *xanthum* (Small) Reveal, comb. nov., based on *E. xanthum* Small, Bull. Torrey Bot. Club 33: 51. 1906.

VAR. JAMESII. [*E. j.* var. *neomexicanum* Gandoger.] Mats up to 8 dm across; leaves mostly narrowly elliptic, 1--3 cm long, 0.5--1 cm wide, the margin entire; inflorescences divided 1--6 times, up 3 dm long; bracts mostly narrowly elliptic, up to 2 cm long and 1 cm wide; involucres 4--7 mm long, 2--5 mm wide; flowers white to cream, 4--8 mm long. -- Widespread and often common from n.-central Colo. s. throughout the e. half of Ariz. e. to n. and w. Tex.; from Coconino Co. s. to Gila and Graham cos., Ariz., and throughout most of N.M. Jun-Sep.

VAR. UNDULATUM (Benth. in DC.) Stokes ex Jones. [*E. u.* Benth. in DC. *E. j.* ssp. *u.* (Benth. in DC.) S. Stokes.] Mats up to 8 dm across; leaves mostly narrowly elliptic, 1--2 cm long, 0.5--1 cm wide, the margin crisped and usually undulate; inflorescences divided 3--6 times, up to 1.5 dm long; bracts narrowly elliptic, up to 1.5 cm long and 0.6 cm wide; involucres 1.5--4 mm long, 2--3 mm wide; flowers white to cream, 3--5 mm long. -- Widespread and often locally common from se. Ariz. and sw. Tex. s. to n. Mex.; currently known only from Ariz. in Cochise, Santa Cruz, Santa Rita and perhaps Gila cos., but to be expected in the mountains of s. N.M. Jul-Sep.

The distinction between var. *jamesii* and var. *undulatum* is a subtle one at best. The northern var. *jamesii* gradually grades into var. *undulatum* in an irregular line from Jeff Davis and Brewster cos., Texas, through the mountain ranges of extreme northern Coahuila and Chihuahua, Mexico, and in southeastern Arizona. The main difference is in the texture of the leaf margin, with that of var. *jamesii* being entire and smooth while that of var. *undulatum* is crisped and wavy or undulate. This broad band of contact caused Johnston (1944) to reject var. *undulatum* as a distinct taxon.

For the most part, var. *jamesii* is a foothill taxon, occurring mainly in the foothills and lower slopes and flats of the Rocky Mountains or desert ranges of Arizona, New Mexico, and Texas. The var. *undulatum* is entirely a montane taxon, usually found well up on the slopes, and at least in Mexico, on the highest ridges.

SUBGENUS PTEROGONUM (H. GROSS) REVEAL

31. E. HIERACIFOLIUM Benth. in DC. [*Pterogonum h.* (Benth. in DC.) H. Gross. *E. pannosum* Wooton & Standley. *E. leucophyllum* Wooton & Standley ssp. *p.* (Wooton & Standley) S. Stokes.] Erect herbaceous perennials 4--7 dm tall; leaves basal and cauline, the leaf-blades oblanceolate to spatulate, 3--15 cm long, 0.5--2 cm wide, sparsely to densely strigose, the petiole 0.5--5 cm long, the cauline leaf-blades oblanceolate, 0.5--5 cm long, sessile; stems erect, 3.5--6.5 dm long, strigose; inflorescences open paniculated cymes, 4--15 (18) cm long, strigose; involucres turbinate-campanulate to campanulate, 2.5--4 mm long, 2.5--5 mm wide, hirsute to strigose without, the 5 triangular teeth 0.5--1.5 mm long; flo-

wers yellow, 1.5--2.5 mm long in anthesis, 3--5 mm long and reddish in fruit, stirgose without, the tepals ± ovate; achenes yellowish-green maturing light brown, 4.5--6 mm long, strigose at the apices along the winged margins on the upper half of the fruit. -- Local and infrequent to common mainly in gravelly soil from e. Ariz. se. across the s. half of N.M. to w. Tex. and n. Chihuahua, Mex.; from Navajo, Apache and Gila cos., Ariz. se. across the s. half of N.M. from Bernalillo Co. s. Jul-Oct

This species can be quickly distinguished from the next by the strigose flowers and the achene which is winged only near the apex. This subgenus has been studied extensively by William J. Hess and myself (Hess & Reveal in press) and our findings will be published shortly.

I cannot explain the actions of Wooton and Standley (1913) in proposing *Eriogonum pannosum*, as it falls well within the definition of *E. hieracifolium*. Both types were collected within a few miles of each other in southeastern New Mexico. However, what is even more impossible to understand is Miss Stokes' attempt to associate *E. pannosum*, a member of the subgenus Pterogonum, with *E. leucophyllum*, a member of the subgenus Eucycla. Both Hess and I have reviewed her comments for a hint of reason, but can find none except that both grow in approximately the same part of New Mexico.

32. E. ALATUM Torr. in Sitgr. Tall erect monocarpic perennials 5--20 dm tall arising from deep soft woody, chambered taproots; leaves basal and cauline, the basal leaf-blades linear-lanceolate to lanceolate, oblanceolate or spatulate, (3) 5--20 cm long, 0.3--2 cm wide, strigose below, becoming glabrous on both surfaces except for the margins and veins, the petiole 2--6 cm long, the cauline leaf-blades linear-lanceolate to lanceolate, 1--9 cm long, ± sessile; stems erect, 2--13 dm long, strigose to nearly glabrous at least below; inflorescences open paniculated cymes, 2--10 dm long, sparsely strigose to glabrous; peduncles erect, slender, 0.5--3.5 cm long, sparsely strigose to glabrous; involucres turbinate to campanulate, 2--4 (4.5) mm long and wide, strigose to glabrous without, the 5 acute to triangular teeth 1--1.8 mm long; flowers yellow to yellowish-green, 1.5--2.5 mm long in anthesis, becoming 3--6 mm long in fruit and often maturing reddish, glabrous without, the tepals lanceolate; achenes yellowish- to greenish-brown, maturing reddish-brown, 5--9 mm long, glabrous, distinctly winged the entire length of the fruit. -- Local and often common from e. Utah, se. Wyo. and w. Neb. s. into n. and e. Ariz., w. Kans. and Okla., n. and w. Tex., N.M., and extreme nw. Chihuahua, Mex.; common throughout n. and e. Ariz. and nearly all of N.M. Jun-Oct.

All three variants of this species occur within the two states of this paper. One, var. *glabriusculum*, just bearly enters the area in northeastern New Mexico, while a second, var. *mogollense*, is wholly confined to north-central Arizona. The most widespread and common form of the species in this area is the typical variant which is common in both states.

KEY TO THE VARIETIES

A. Flowering stems and inflorescences strigose, or if the inflorescence glabrous, then the plants of northern Arizona; leaves linear-lanceolate to oblanceolate or spatulate; widespread and common.
  B. Basal leaves linear-lanceolate to lanceolate or oblanceolate, 0.3--1.5 cm wide, the petiole-bases sparsely strigose to strigose; common . . . . var. *alatum*
  BB. Basal leaves spatulate, 1--2 cm wide, the petiole-bases densely strigose; Coconino and Navajo cos., Arizona . . . . var. *mogollense*

AA. Flowering stems and inflorescences glabrous or only slightly strigose when young; leaves linear-lanceolate; Curry Co., New Mexico . . . . var. *glabriusculum*

VAR. ALATUM. [*E. triste* S. Wats. *E. a.* ssp. *t.* (S. Wats.) S. Stokes.] Plants 5--15 (17) dm high; leaves with sparsely strigose petiole-bases, lanceolate to oblanceolate; inflorescences thinly strigose, infrequently glabrous. -- Widespread and common throughout the range of the species except for n. Tex. and w. Okla.; common throughout most of the two states except in sw. Ariz. Jun-Oct.

In portions of northern Arizona, an occasional individual of var. *alatum* will be found in late anthesis or in fruit which will have glabrous stems and inflorescence branches. Such plants are usually, but not always, mixed with thinly strigose plants. The distinction of such glabrous individuals hardly seems logical, and *Eriogonum triste* is reduced to synonymy.

VAR. MOGOLLENSE Stokes ex Jones. [*E. a.* var. *macdougalii* Gandoger. *E. a.* ssp. *m.* (Stokes ex Jones) S. Stokes.] Plants 8--13 dm high; leaves with densely strigose petiole-bases, spatulate; inflorescences strigose. -- Local and usually common on the Mogollon Rim of central Coconino Co. e. to Navajo Co., Ariz. Jun-Sep (Oct).

The distinction between var. *alatum* and var. *mogollense* is not a sharp one, and scattered populations of var. *alatum* within the range of var. *mogollense* are not uncommon. In general, the Mogollon buckwheat has broader and shorter leaves which are densely strigose on the petiole-bases so that the basal portion of the plant at ground level is densely clothed with hairs. This phase grades into var. *alatum* to the north and east so that some populations in Navajo, Apache, and Gila cos., for example, can be difficult to place in either taxon. We (Hess & Reveal in press) have tried to restrict the distribution of var. *mogollense* to include only those plants of the pine forest area around Flagstaff, and southeastwardly along the edge of the Mogollon Rim to southern Navajo Co.

VAR. GLABRIUSCULUM Torr. in Sitgr. Plants 1--2 m high; leaves with sparsely strigose petiole-bases, lanceolate; inflorescences

glabrous. -- Local and infrequent to rare from Curry Co., N.M. e across n. Tex. to w. Okla. Jul-Oct.

This is the common form of the species in northern Texas and western Oklahoma. It just bearly enters New Mexico where it occurs on limestone outcrops and thin, gravelly soil in open grasslands.

SUBGENUS GANYSMA (S. WATS.) GREENE

33. E. ARIZONICUM Stokes ex Jones. Erect, spreading herbaceous perennials 2.5--5 (6) dm high, forming loose mats 3--8 cm across; leaves basal but sheathing up the stems and exposed caudex branches 0.5--15 cm, the leaf-blades ovate to rounded, (0.5) 1--2 cm long and wide, densely white-pilose on both surfaces, the hairs becoming less densely matted at maturity, the margin entire and undulate-crispate, the base rounded to truncate, the petiole (0.5) 1--2.5 (4) cm long, pilose to nearly tomentose, the petiole-base strigose to pilose and brown without; stems erect, slender, 1--3 dm long, glabrous and glaucous; inflorescences narrowly cymose, erect, 1--3.5 (4) dm long, trichotomously branched at the first node, often with one or two additional branches or a single elongated peduncle, otherwise dichotomously branched throughout with a peduncle in the fork at each node, glabrous and glaucous; peduncles capillare to slender, erect, 0.5--2.5 cm long, glabrous and glaucous; involucres turbinate, (0.8) 1--2 mm long, (0.8) 1--1.5 mm wide, glabrous without, the 5 acute teeth 0.3--0.8 mm long; flowers yellowish to yellowish-red with a greenish or reddish to reddish-brown midrib and base, (1) 1.5--2 mm long in anthesis, becoming 2--3 mm long and pinkish to reddish in fruit, glabrous, the tepals slightly dimorphic, the outer tepals obovate with broadly expanded bases especially in fruit, the inner tepals obovate but without the broadly expanded bases; achenes dark brown, 1.5--2 mm long. -- Local and rare in widely scattered locations mainly on limestone soils in s. Gila, e. Maricopa, and extreme ne. Pinal cos. in se. Ariz., and near Rock Springs, Yavapai Co., and s. of Kingman, Mohave Co., Ariz. (Jun) Sep-Nov.

This beautiful perennial buckwheat has become so totally confused in the Arizona literature that its identity will take some fresh review. Kearney and Peebles (1951) placed the name in synonymy under *Eriogonum capillare* Small, a slender, delicate, late-fall flowering annual of southeastern Arizona. There key, however, fits *E. arizonicum* (although they thought the plants were possibly biennial). Shreve and Wiggins (1964) followed Kearney and Peebles and their description applies essentially to *E. arizonicum* and not *E. capillare*. In his unpublished doctoral dissertation of this part of the genus, Anderson (1959) recognized both species, but his descriptions for both fit equally well only *E. arizonicum*. I believe this will be the first time the exact identity of the two species will have been published.

The type of *Eriogonum arizonicum* was collected by Orcutt from an unknown location in the state of Arizona.

34. E. INFLATUM Torr. & Frém. Erect, first-year flowering perennials or strictly annuals (outside our area) 1--15 dm high; leaves oblong-ovate to oblong or rounded to reniform, (0.5) 1--2.5 (3) cm long, (0.5) 1--2 (2.5) cm wide, short-hirsute on both surfaces, infrequently less so to villous or glabrate above, the margin entire or crisped-undulate, the petiole 2--6 cm long; stems usually fistulose or inflated, sometimes slender, usually glabrous or merely pubescent at the base, (0.2) 1--4 dm long; inflorescences cymose, open, 0.5--5 dm long, 0.5--8 dm wide, the branches occasionally inflated, glabrous, with 3--5 branches at the first node; peduncles filiform to capillary, erect, 5--20 mm long, glabrous; involucres turbinate, 1--1.5 mm long, 1--1.8 mm wide, glabrous or with the teeth slightly glandular in some, 5-toothed; flowers yellow with reddish or greenish midribs and bases, (1) 2--2.5 (3) mm long, short-hirsute without, the tepals lance-ovoid to ovoid; achenes light brown to brown, 2--2.5 mm long. -- Widespread and common from e. and s. Calif. e. across Nev. and Utah to w. Colo. and then s. to s. Baja Calif. Sur and Sonora, Mex.; throughout most of Ariz. except the e. tier of cos. Mar-Oct (Dec).

VAR. DEFLATUM I. M. Johnston. [*E. glaucum* Small. *E. trichopes* Torr. ssp. *g.* (Small) S. Stokes.] Plants first-year flowering perennials 5--15 dm high; stems not inflated. -- Infrequent to locally common in s. Calif. and s. Ariz. s. to Sonora and Baja Calif. Sur, Mex.; mainly in the s. cos. of Ariz. Jul-Oct (Dec).

This variant is weakly defined in the northern part of its range in southern Arizona and California where it gradually grades into var. *inflatum*. For the most part the two can be distinguished on the degree (or lack of) stem inflation. Additionally, the var. *deflatum* is a more strictly erect plant than the typical form.

VAR. INFLATUM. [*E. clutei* Rydb.] Plants first-year flowering perennials (0.5) 2--10 dm high; stems inflated. -- Common and widespread from w. Colo. to e. Calif. and s. to n. Mex.; common and widespread in Ariz. except in the e. tier of cos., and becoming less frequent in the s. tier of cos. Mar-Oct.

The matter of *Eriogonum clutei* must once again be dealt with after the publication of the name by McDougall (1973) in spite of my personal comments to him on this taxon, and the publication on the status of this confused plant (Reveal 1968a). The type of this species is based on a basal rosette of *E. deflexum* while the inflorescence is *E. inflatum*. Rydberg (1921) did not detect this problem, and on the basis of the confused collection sent to him from Arizona, proposed the new species. In 1968, I lectotypified the name, *E. clutei*, on the inflorescence fragment of *E. inflatum* and the name is a synonym of that species.

As for var. *inflatum* itself, it is one of the more common species of the genus in Arizona, being found as far east as Graham Co. in the state. It is to be sought in southwestern New Mexico, as the next species, *E. trichopes*, occurs across the southern part of that state and apparently into the El Paso area of Texas.

35. E. TRICHOPES Torr. in Emory. [*E. trichopodum* Torr. ex Benth. *E. trichopodum* var. *minus* Benth. in DC. *E. trichopes* ssp. *m.* (Benth. in DC.) S. Stokes.] Erect herbaceous annuals 1--4.5 (6) dm high; leaves round-oblong to rounded, 1--2.5 (4) cm long, 1--2 (3) cm wide, hirsute, the margin entire or crenulate, the petiole 1--6 cm long; stems erect, slender, rarely fistulose, glabrous or only minutely hirsute at the base, 0.5--1.5 (2) dm long; inflorescences densely paniculated cymes, 0.5--4 dm long with numerous secondary branchlets at the lower (and especially the first node), glabrous; peduncles ± erect, capillary, 5--15 mm long, glabrous; involucres turbinate, 0.7--1 mm long, 0.6--0.9 mm wide, glabrous without, 4-toothed; flowers yellowish to greenish-yellow, 1--2 (2.5) mm long, short-hirsute without, the tepals lance-ovate; achenes light brown to brown, 1.5--2 mm long. -- Widespread and often weedy from e. and s. Calif. e. to sw. Utah, w. and s. Ariz., s. N.M., extreme w. Tex., and n. Mex.; common and locally weedy in good years from Mohave Co. s. to Yuma Co. se. and e. across the s. tier of cos. in N.M. as far e. as Dona Aña Co. Mar-Jul (Dec).

This common, weedy species is occasionally confused with *Eriogonum inflatum*. In general, *E. trichopes* is a strict annual with numerous, fine branches in a dense inflorescences, and a 4-toothed involucre. Only in very young, healthy plants of *E. inflatum* is it nearly as bushy as *E. trichopes*, and then the stems are usually so grossly inflated, and the peduncles and lower branches so stout, that the two can still be distinguished even from a distance. In the latter regard too, from a distance, *E. trichopes* is a bright yellowish-green while the other species is a dull, grayish-green.

36. E. TENELLUM Torr. [*E. t.* var. *leptocladon* Benth. in DC.] Erect to spreading herbaceous perennials 1--5 dm high; leaves elliptic to ovate or orbicular, 3--15 mm long, 3--10 mm wide, densely tomentose on both surfaces, the petiole 4--20 mm long; stems slender to stoutish, 4--20 cm long, glabrous; inflorescences open, erect or spreading, 0.5--4 dm long, glabrous; peduncles slender, erect, straight, 0.5--6 cm long, glabrous; involucres turbinate, 2--4 mm long, 1.5--3 mm wide, glabrous without, tomentose within, 5-toothed; flowers white, 1.5--2.5 mm long in anthesis, becoming 2.5--3.5 mm long and pink or orange-brown or reddish in fruit, glabrous, the tepals dimorphic, those of the outer whorl ovate to obovate or suborbicular, the bases subcordate to cordate, 1.5--2 mm wide, those of the inner whorl narrowly oblong to oblong, 0.5--1 mm wide; achenes light brown to brown, 2--3 mm long. -- Widespread and usually locally common from se. Colo. and sw. Kans. s. through N.M. and Tex. to ne. Mex.; from Colfax Co. s. to Torrance and Lincoln cos. then se. to Eddy Co., N.M. Jun-Sep.

Our plants belong to the var. *tenellum*.

37. E. PARISHII S. Wats. Low spreading herbaceous annuals 1--3 dm high; leaves spatulate, 2--6 cm long, 0.5--2 cm wide, hirsute and green on both surfaces, the petiole 0.5--2.5 cm long, ± winged; stems 3--10 cm long, glabrous except for the glandular

upper node; inflorescences hemispherical and forming dense masses 1--4 dm across, glabrous except for the glandular nodes; peduncles spreading, capillary, 4--12 mm long, glabrous or sparsely glandular; involucres turbinate, 0.5--0.9 mm long, glabrous without, 4-toothed; flowers red to pink, 0.5--0.7 mm long in anthesis, becoming 0.7--0.9 mm long and whitish with red midribs in fruit, minutely puberulent without, the tepals ovate; achenes dark brown, 1--1.3 mm long. -- Infrequent to locally common from s. Calif. and w. Ariz. s. to n. Baja Calif., Mex.; known only from Yavapai Co., Ariz. Jul-Oct.

In the 1969 edition of ARIZONA FLORA, Howell and McClintock (Kearney & Peebles 1969) reported the discovery of this species for the Arizona flora. I have seen no other collections except the Beaty collection they cited. Even so, McDougall (1973) fails to report the species from his area.

38. E. ORDII S. Wats. [*E. tenuissimum* Eastw.] Erect slender herbaceous annuals (0.5) 1--7 dm high; leaves basal and occasionally cauline, the basal leaf-blades oblong-oblanceolate or oblong-obovate to obovate, 2--8 cm long, 1--3 cm wide, thinly floccose to glabrous and green especially on the upper surface, the petiole 2--6 (10) cm long, the cauline leaf-blades restricted to the lower 1--3 nodes, elliptic to obovate, 0.7--3 cm long, 0.2--2 cm wide, otherwise similar to the lower leaves; stems erect, slender, (0.3) 0.7--3 dm long, loosely floccose near the base, glabrous above; inflorescences diffusely paniculate, ± erect, (0.5) 1--5 dm long, glabrous except for scattered floccose hairs at the nodes and along the lower branches; peduncles erect, capillary, 5--20 mm long, glabrous or nearly so; involucres narrowly turbinate to turbinate, 1--1.5 (1.8) mm long, glabrous without, 4-toothed; flowers white to pale yellow, 1--1.5 mm long in anthesis, becoming 1.5--2.5 mm long and pink to red in fruit, short-villous, the tepals narrowly oblong to ovate; achenes dark brown to black, 1.8--2.1 mm long. -- Local and usually rare in widely scattered locations from nw. Ariz. to w.-central Calif.; known only from the type collection taken near Fort Mohave, Mohave Co., Ariz. Mar-Jun.

Kearney and Peebles (1951) question the label data for this species' type, noting that "in view of the known distribution of the species in California, the absence of later collections from Arizona, and the uncertainty of Lemmon's data of locality, it is improbable that *E. ordii* really occurs in this state." McDougall (1973) makes no statement regarding this species by simply ignoring its existence. However, a critical consideration of this is the name of the taxon itself. James L. Ord was a contract surgeon with the United States Army from 1846 to 1891, and in 1884 was stationed at Fort Mohave, Arizona. Watson (1886) indicates that he is naming the plant for Ord at the request of John G. Lemmon, and it seems reasonable that Lemmon could have found Ord only at Fort Mohave. Lemmon's field records are extant, but often difficult to understand, and as yet, I have found no reason to assume that the type of this species did not come from Arizona. Careful

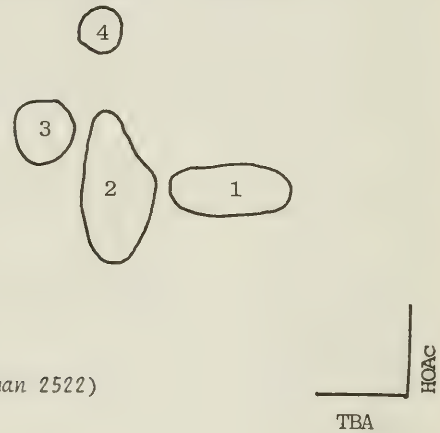
field studies in Mohave Co. may yet reveal this taxon in the Arizona flora. It is rarely found in the deserts of adjacent San Bernardino Co., California, where it seems to be restricted to the mountains.

39. E. ALIQUANTUM Reveal. Erect spreading herbaceous annuals 1.5--3.5 dm high arising from a slender, woody taproot; leaves basal and cauline, the basal leaf-blades elliptic to broadly elliptic, 1.5--2 cm long, 1--1.5 cm wide, glabrous and green on both surfaces except for sparsely scattered villous hairs along the margin and midvein, occasionally sparsely villous above when young, the margin entire and plane, the apex mostly obtuse, the base obtuse, the petiole slender, 1.5--2.5 cm long, sparsely villous, the petiole-base triangular, villous without, glabrous within, the cauline leaf-blades elliptic, 0.5--1.5 cm long, 0.2--1 cm wide, similar to the basal leaves only more reduced, the petiole short and the leaves restricted to the nodes in the axil of the bracts nearly thoughout the plant; stems erect, slender, 3.5--7 cm long, sparsely villous with white hairs; inflorescences open, 1.5--2.5 dm long, mostly trichotomously branched at the first node, dichotomous above, sparsely villous throughout but becoming slightly less so above; bracts scalelike, ternate, triangular, 1--4 mm long, glabrous within and without except for the ciliated margins, connate basally; peduncles lacking except for a rare one in the fork of the first node in some, these erect, 3--7 mm long, villous; involucres turbinate-campanulate, 1--1.3 mm long, 1--1.2 mm wide, glabrous within and without except for a ciliated margin, the 5 acute teeth 0.4--0.6 mm long, the bractlets linear-oblanceolate, 1.5--2 mm long, minutely glandular with a few, white, marginal hairs at the apex in some, the pedicel 2--2.5 mm long, glabrous; flowers yellowish with a slightly darker yellowish-brown to brownish-red midrib, 1.2--1.5 mm long in anthesis, becoming 1.5--2 mm long, reddish in fruit, glabrous without, sparsely hispid along the margin of the tepals and otherwise glabrous within, the tepals essentially similar, oblanceolate, 0.4--0.7 mm wide, united about 1/5 the length of the flower; stamens slightly exserted, 1.3--1.5 mm long, the filaments glabrous, the anthers reddish-yellow, 0.3--0.4 mm long, oblong; achenes light brown to brown, 1.7--2.3 mm long, the large globose base tapering to a long, stoutish, 3-angled beak. -- Rare and highly restricted to clay hills s. of Cimmaron and near Philmont Scout Ranch, ca 6600 ft elev, Colfax Co., N.M. Jun-Aug.

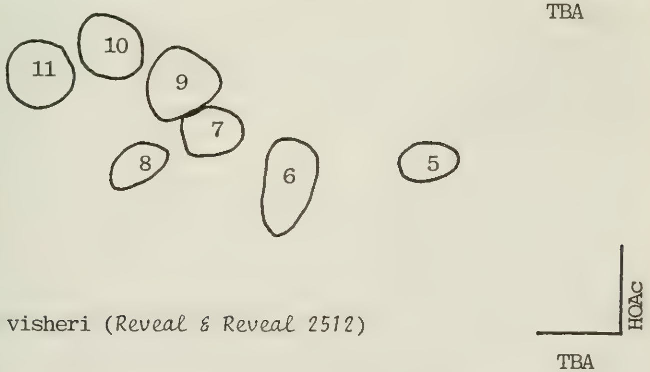
Eriogonum aliquantum Reveal, sp. nov. *E. visheri* A. Nels. affinis, a qua imprimis differt floribus glabris, achaenis brevioribus et foliis angustioribus. -- TYPUS: On low clay, eroded hills east of an irrigation ditch 0.3 mile west of New Mexico Highway 21, 4.4 miles south of U.S. Highway 64 at Cimmaron, near the Philmont Scout Ranch, associated with low, scattered shrubs at ca 6600 ft elev, Colfax Co., New Mexico, 14 Jul 1972, *Reveal & Reveal 2770*. Holotype, US. Isotypes, to be distributed from US. Additional Collections: NEW MEXICO: Colfax Co.: Cimarroncito Road, 1/4 mi W of Philmont Scout Ranch Hdq., 31 Jul 1968, *Hartman 2522*

(RM, US); 1.2 mi S of Cimmaron on N.M. Hwy 21, 14 Jul 1972, *Reveal & Reveal 2771* (BRY, NY, US).

This new species is clearly related to *Eriogonum visheri* which occurs in North and South Dakota on shallow, gravelly to rocky or clayey soils in the western parts of these two states. The two are morphologically similar in numerous ways, with *E. aliquantum* differing mainly in having glabrous flowers, shorter achenes, and narrower leaves. The aspect of the two are very similar. The new species was discovered by Ronald L. Hartman, then a student at the University of Wyoming, and at my request, ran a two dimensional flavonoid diagram on each species using the thin layer chromatography technique. Below are the results of Hartman's study:



Eriogonum aliquantum (*Hartman 2522*)



Eriogonum visheri (*Reveal & Reveal 2512*)

As can be easily seen, the leaf flavonoid compounds of these two species are different, with only compounds 1, 2, 3, 5, 6, and 7 probably held in common.

I am grateful to Dr. Hartman, who has since graduated from the University of Texas, for his aid in this matter.

40. E. GORDONII Benth. in DC. [*E. trinervatum* Small.] Erect herbaceous annuals 1--4 (6) dm high; leaves basal, obovate to rounded or reniform, 1--5 cm long and wide, sparsely villous to hirsute on both surfaces, often becoming glabrous, the petiole 1--5 cm long; stems erect, 5--15 cm long, sparsely hispid at the base in some, otherwise glabrous; inflorescences open to ± dense, 5--30 cm long, sparsely hispid or more commonly glabrous; peduncles slender, erect, 0.5--2 cm long, glabrous, rarely slightly hirsute or hispid near the base; involucres campanulate, 0.6--1.3 mm long, 0.8--1.5 mm wide, glabrous, 5-toothed; flowers white with greenish to reddish-brown midribs and bases, becoming pinkish to rose in fruit in some, 1--2.5 mm long, glabrous without, the tepals oblong-ovate to oblong; achenes light brown to brown, 2--2.5 mm long. -- Mostly on clay hills and flats from w. Neb. and s. Wyo. s. across e. Utah and w. Colo. to nw. N.M. and ne. Ariz.; Apache Co., Ariz. and San Juan Co., N.M. Jun-Sep.

Although not mentioned by Kearney and Peebles (1951, 1969) nor McDougall (1973), this species was collected by Deaver on Black Mountain in 1952 (MNA).

41. E. CAPILLARE Small. Erect herbaceous annuals 2--4 dm high; leaves basal, obovate to rounded, 1--3 cm long and wide, sparsely villous to hirsute and green on both surfaces, the margin entire, the apices rounded to obtuse, the bases truncate to rounded, the petiole 1--3 cm long, glabrate to sparsely hirsute; stems erect, 5--15 cm long, glabrous and glaucous; inflorescences open to dense paniculated cymes, 1--3 dm long, ± erect but spreading, glabrous to glaucous, trichotomously branched at the first node, dichotomously branched above, the ultimate branches often slender; peduncles slender, 1--3 cm long, erect and straight, glabrous and glaucous; involucres campanulate, 1--1.5 mm long and wide, glabrous without, the 5 acute to rounded teeth 0.3--0.5 mm long; flowers white with green or reddish midribs and bases, 0.8--1.2 mm long at anthesis, becoming 1.2--1.6 mm long and pinkish in fruit, glabrous, the tepals slightly dimorphic, the outer whorl of tepals pandurate with the two auriculated basal lobes wider and somewhat swollen when compared to the apex, those of the inner whorl oblanceolate with truncated apices; achenes brown to black, 1.3--1.6 mm long. -- Local and exceedingly rare, known from near San Carlos, Gila Co., and near Peridot, Graham Co., Ariz. Jul-Oct.

As already noted in the discussion of *Eriogonum arizonicum*, it and this species, *E. capillare*, have been terribly confused by Kearney and Peebles (1951) and Shreve and Wiggins (1964) so that it is only now, for the first time since the original description (Small 1898) that this rare plant has been adequately and accurately described. The species is still known to me only from a small number of collections, and this is in part due to the late season at which it flowers. I have considered this plant as "endangered" due to its rareness, the heavy grazing of animals on the San Carlos Indian Reservation, and the heavy highway traffic along U.S. Highway 70. It is now impossible to know to what extend the construction of San Carlos Lake has had on the rareness of this species.

42. E. DEFLEXUM Torr. in Ives. Erect to spreading herbaceous annuals (0.5) 1--7 (10) dm high; leaves cordate to reniform or nearly orbicular, 1--2.5 (4) cm long, 2--4 (5) cm wide, tomentose below, floccose to subglabrous and greenish above, the petiole 1--7 cm long; stems slender (ours) to fistulose, 3--30 cm long, glabrous; inflorescences erect or spreading, open to diffuse, 1--5 dm long, glabrous; peduncles lacking to 15 mm long, slender to stout, deflexed, glabrous; involucres narrowly turbinate to turbinate, 1--2.5 (3) mm long, 1--2.5 mm wide, glabrous without, 5-toothed; flowers white to pink, maturing reddish in some, 1--2.5 (3) mm long, glabrous without, the tepals dimorphic, those of the outer whorl ovate to oblong, the base obtuse to cordate, those of the inner whorl lanceolate to narrowly ovate; achenes brown to dark brown, (1.5) 2--3 mm long. -- Widespread and common from e. Calif. across Nev. to w. and s. Utah, s. through s. Calif. and Ariz. to Sonora and Baja Calif., Mex.; widespread and common in Ariz. except in the ne. portion of the state. May-Oct (Jan).

Since my review of this species (Reveal 1968a), I have added the var. *nevadense* (Reveal 1973) to the complex, applying this name to the phase of the species with sessile involucres found in the Great Basin of Nevada and Utah. As noted in 1968, the distinction between the two Arizona variants is slight, and the two tend to grade into each other.

VAR. DEFLEXUM. [*E. d.* forma *stenopetale* H. Gross.] Plants up to 5 dm high; peduncles 1--3 (5) mm long; involucres turbinate, 1.5--2 mm long, few flowered; flowers 1--2 mm long, the tepals oblong. -- Common throughout the range of the species; Mohave Co. e. to s. Navajo Co., and s. to Yuma Co., with scattered populations in Pinal, Pima, Maricopa, and Gila cos., Ariz. May-Sep (Oct).

VAR. TURBINATUM (Small) Reveal. [*E. t.* Small.] Plants up to 4 dm high; peduncles 3--5 mm long; involucres turbinate, 2--2.5 mm long, many flowered; flowers 1.5--2 mm long, the tepals subcordate. -- Common in s. Ariz. and n. Sonora, Mex.; widespread and common in s. Ariz. from Maricopa Co. e. to Greenlee Co. s. to the Mexico line. May-Oct (Dec.)

43. E. HOOKERI S. Wats. [*E. deflexum* Torr. in Ives ssp. *h.* (S. Wats.) S. Stokes.] Erect herbaceous annuals 1--6 dm high; leaves cordate to subreniform, (1) 2--5 cm long, 2--6 cm wide, tomentose on both surfaces or slightly less so above, the petiole 1--5 cm long; stems slender to stout, 0.5--3 cm long, glabrous; inflorescences spreading, subglobose to ± flat-topped, up to 5 dm across, glabrous; peduncles lacking; involucres broadly campanulate to hemispheric, 1--2 mm long, 1.5--3 (3.5) mm wide, deflexed, glabrous, 5-toothed; flowers yellow, becoming reddish-yellow in fruit, 1.5--2 mm long, glabrous, the tepals dimorphic, those of the outer whorl orbicular or hastate, those of the inner whorl oblong; achenes light brown, 2--2.5 mm long. -- Infrequent to locally common from e. Calif. to sw. Wyo., w. Colo., n. Ariz. and perhaps nw. N.M.; known

from Coconino and Mohave cos., Ariz., but to be expected in n. Apache Co., Ariz., and nw. San Juan Co., N.M. Jul-Oct.

44. E. BRACHYPODUM Torr. & Gray. [*E. parryi* A. Gray. *E. deflexum* Torr. in Ives var. *b.* (Torr. & Gray) Munz. *E. d.* ssp. *b.* (Torr. & Gray) S. Stokes. *E. d.* ssp. *p.* (A. Gray) S. Stokes.] Low spreading to erect herbaceous annuals 0.5--3 (4) dm high; leaves orbicular to cordate, 1--3 (4) cm long, (1.5) 2--4 (5) cm wide, densely tomentose below, tomentose to subglabrous and green above, the petiole 1--4 cm long; stems slender to stout, 2--7 cm long, glandular; inflorescences horizontal in low, flat-topped crowns, or spreading and forming more open, subglobose crowns, the branches glandular throughout; peduncles slender to stoutish, up to 15 mm long, deflexed, glandular; involucres turbinate to campanulate, 1--2.5 mm long, 1.5--2.5 mm wide, glandular without, 5-toothed; flowers white to reddish, 1--2.5 mm long, glabrous, the tepals dimorphic, those of the outer whorl oblong to ovate with cordate to auriculate bases, those of the inner whorl oblanceolate; achenes brown to blackish-brown, 1.5--2 mm long. -- Widespread and common, often forming weedy patches along the highways from e. Calif. e. across s. Nev. to sw. Utah and nw. Ariz.; known only from Mohave Co., Ariz. Mar-Oct.

In my revision of the *Eriogonum deflexum* complex (Reveal 1968a) I proposed that *E. parryi* be considered a synonym of *E. brachypodum* as the supposed differences between the two (mainly the length of the peduncles) simply did not hold up under critical examination. The type of *E. parryi* was a young individual collected early in the growing season, and most young plants of *E. brachypodum* show the open, spreading habit, although the involucres may or may not be as long as in the Utah population named for Parry. The two species cannot be maintained.

45. E. INSIGNE S. Wats. [*E. exaltatum* M. E. Jones. *E. deflexum* Torr. in Ives var. *i.* (S. Wats.) M. E. Jones. *E. d.* ssp. *i.* (S. Wats.) S. Stokes. *E. d.* ssp. *e.* (M. E. Jones) S. Stokes.] Tall erect herbaceous annuals (0.5) 3--10 dm high; leaves subcordate to orbicular, (1.5) 2--5 (8) cm long and wide, tomentose below, floccose to subglabrous and greenish above, the petiole 1--10 cm long; stems stout, (0.2) 2--20 cm long, glabrous; inflorescences narrow, strict, (0.5) 1--8 dm long, glabrous, the branches long and whip-like with racemosely arranged involucres at the tips; peduncles erect, up to 2 mm long, glabrous; involucres turbinate, 2--2.5 (3) mm long, 1.5--2.5 mm wide, glabrous, 5-toothed; flowers white with greenish to reddish midribs and bases, 1.5--2 mm long, glabrous, the tepals dimorphic, those of the outer whorl oblong with cordate bases, those of the inner whorl oblanceolate; achenes dark brown to blackish, 2--2.5 mm long. -- Local and often rare in sandy soil from s. Calif. across s. Nev. to sw. Utah and nw. Ariz.; known only from Mohave Co., Ariz. May-Oct.

This is another of the many species of *Eriogonum* not included in McDougall's (1973) recent flora of northern Arizona although

it presence in Arizona had been reported earlier (Reveal 1968a).

46. E. SCABRELLUM Reveal. Erect and spreading herbaceous annuals 1--5 dm high; leaves cordate, 1--3 cm long and wide, densely tomentose below, floccose above, the margin crisped and wavy, the petiole 1--4 cm long; stems slender, 5--15 cm long, sparsely to rather densely tomentose, scabrellous throughout; inflorescences ± flat-topped, 0.5--4 dm high and across, the branches lightly to sparsely floccose, becoming less obviously so in age, scabrellous throughout; peduncles lacking; involucres turbinate, 1.5--2.5 mm long, 1.5--2 mm wide, horizontally arranged on the branches, becoming somewhat deflexed with age, arising from the bracts along the edge of the branch, the tube scabrellous, 5-toothed; flowers white to pink or rose to red, 1--1.5 mm long, pustulose without, the tepals dimorphic, those of the outer whorl obovate with obtuse bases, those of the inner whorl ovate; achenes light brown, 2 mm long. -- Rare and locally common on clay hills and flats in e. Utah and w. Colo.; to be expected in extreme n. Coconino or Apache cos., Ariz. or extreme nw. San Juan Co., N.M. (Jul) Aug-Oct (Nov).

This late fall flowering species of the *Eriogonum deflexum* complex has, in recent years, become better known insofar as its distribution (Reveal 1973). I have seen it now from Grand Co., Utah south to San Juan and Kane cos., Utah, mainly along the Colorado River drainage system. In Colorado, it is in Mesa Co., also along the Colorado River, but in Montezuma Co. (and in San Juan Co., Utah, also) it is along the San Juan River drainage. I suspect that it will be found eventually in both Arizona and New Mexico if sought for in the late summer and fall of the year.

47. E. CERNUUM Nutt. [*E. c.* var. *tenue* Torr. & Gray. *E. c.* var. *umbraticum* Eastw. *E. c.* ssp. *t.* (Torr. & Gray) S. Stokes.] Low to high, spreading to erect herbaceous annuals 0.5--6 dm high; leaves basal or sheathing up the stems, ovate to orbicular, (0.5) 1--2 (2.5) cm long and wide, densely tomentose below, tomentose to floccose or subglabrous and greenish above, the petiole 1--4 cm long; stems slender, 0.3--2 dm long, glabrous; inflorescences open, erect or spreading, 0.5--5 dm high and up to 4 dm across, the branches glabrous and often glaucous; peduncles lacking or (in ours) present, slender, cernuous, spreading or ascending, 1--25 mm long, glabrous; involucres turbinate, (1) 1.5--2 mm long, 1--1.5 mm wide, glabrous, 5-toothed; flowers white to pinkish with greenish to reddish midribs and bases, 1--2 mm long, glabrous, the tepals dimorphic, those of the outer whorl panduriform with crisped or slightly wavy margins, those of the inner whorl obovate; achenes light brown to brown, 1.5--2 mm long. -- Common and widespread throughout much of central North America, from e. Calif. e. to Colo., and from sw. Can. s. to Ariz. and N.M.; common across the n. tier of cos. in Ariz. into N.M. as far e. as Santa Fe Co. and as far s. as Catron Co. Jun-Oct.

Our plants belong to var. *cernuum*, with the var. *viminale* (S. Stokes) Reveal in Munz restricted to the Great Basin area of Utah

and Nevada essentially. The var. *umbraticum* was a named proposed for those plants of the typical variant which have sheathing leaves. The distinction is not worthy of consideration.

48. E. ROTUNDIFOLIUM Benth. in DC. [*E. cernuum* Nutt. ssp. *r.* (Benth. in DC.) S. Stokes. *E. c.* ssp. *glaucescens* S. Stokes. *E. r.* var. *angustius* Goodman.] Low spreading herbaceous annuals 0.5--4 dm high; leaves orbicular to cordate, 1--2 cm long, 1--2.5 cm wide, tomentose below, floccose to subglabrous and grayish or greenish above, the petiole 1.5--4 cm long; stems slender, 1--5 (7) cm long, glabrous; inflorescences open, spreading, ± flat-topped, glabrous and frequently glaucous throughout; peduncles stoutish, erect, 3--15 mm long, glabrous; involucres turbinate to campanulate, 1--2 mm long, 1.5--2.5 mm wide, glabrous without, 5-toothed; flowers white to rose or red, 1--2 mm long, glabrous, the tepals dimorphic, those of the outer whorl flabellate, 1--2.5 mm wide, those of the inner whorl lanceolate, 0.4--0.7 mm wide; achenes dark brown to blackish, 1.5--2 mm long. -- Locally common in widely scattered locations from N.M. and central and w. Tex. s. to se. Ariz., Coahuila and Chihuahua, Mex.; from Valencia and De Baca cos., N.M., s. to Greenlee and Cochise cos., Ariz. Apr-Oct.

This species is easy to distinguish from *Eriogonum cernuum* by the features presented in the flower, involucre, and peduncle, and the two need never be confused. Why Stokes (1936) proposed ssp. *glaucescens* is beyond me as it falls well within any definition of the species.

49. E. THURBERI Torr. [*E. panduratum* S. Wats. *E. cernuum* Nutt. ssp. *t.* (Torr.) S. Stokes. *E. c.* ssp. *viscosum* S. Stokes.] Low spreading to roundish herbaceous annuals 0.5--4 dm high; leaves oblong-ovate, 0.4--4.5 cm long, 0.5--3 cm wide, tomentose below, floccose to glabrate and dark green above, the margin usually rugulose, the petiole 1--3 cm long; stems slender, 0.3--1 dm long, wooly-pubescent and sparsely to densely glandular; inflorescences open to compactly branched, spreading, 0.5--3 dm long, sparsely glandular to glabrate; peduncles erect, capillary, 5--25 mm long, glabrous with the upper end glandular-puberulent; involucres broadly turbinate, 1.8--2 mm long and wide, minutely glandular-puberulent without, 5-toothed; flowers white to red or rustic, 1--1.7 mm long, glabrous except for the glandular-puberulent base without, glabrous within except for a tuft of long white hairs about midlength, the tepals dimorphic, those of the outer whorl broadly pandurate or flabellate, 1--2 mm across, those of the inner whorl oblanceolate, 0.2-0.5 mm wide; achenes brown to black, 0.6--0.8 mm long. -- Widely scattered and usually infrequent to weedy from s. Calif. and s. Ariz., s. to nw. Mex.; from Mohave Co. se. to Graham and Cochise cos., w. to Yuma Co., Ariz. Mar-Jul (Oct).

This is a common desert species in much of western and southern Arizona. It is to be expected in extreme southwestern New Mexico, but I have seen no specimens. The type of *Eriogonum panduratum* may have been collected in Arizona.

50. E. THOMASII Torr. [*E. minutiflorum* S. Wats.] Low spreading herbaceous annuals 0.5--3 dm high; leaves round to round-reniform, 5--20 mm long and wide, densely tomentose below, floccose to glabrate above, the petiole 5--30 mm long; stems slender, 2--10 cm long, glabrous except for a few scattered glands near the base in some; inflorescences spreading, open to diffuse, 0.5--2.5 dm long and across, glabrous; peduncles spreading, capillare, 5--20 mm long, glabrous; involucres turbinate-campanulate, 0.6--1.2 mm long, 0.7--1.3 mm wide, glabrous, 5-toothed; flowers yellow and 0.8--1 mm long at anthesis, becoming white to rose and 1.2--2 mm long in fruit, short-hispidulous without, the tepals dimorphic, those of the outer whorl plane in early anthesis but soon becoming saccate-dialated on each side of the cordate base, the inflated area often white to pink, those of the inner whorl spatulate and often as long to slightly longer than the tepals of the outer whorl; achenes brown to dark brown, 0.8--1 mm long. -- Infrequent to common in sandy soil from se. Calif. e. across s. Nev. to sw. Utah, and s. through w. Ariz. to nw. Mex.; Mohave and Yuma cos. e. across the s. part of Ariz. to Graham Co. Feb-Jun (Aug).

Care must be taken in identifying this species to look closely at the outer tepals, and especially the base of the tepals. When mature, the flowers are prominently saccate, but when immature, the flowers (and plants) can be confused with *Eriogonum pusillum*. A simple way of discriminating between the two is in the shape of the leaves, with those of *E. thomasii* round to reniform in outline and densely tomentose but dark green to even reddish-green above, while the leaves of *E. pusillum* are usually longer than broad, densely tomentose below but with longer hairs and yellowish-green on the upper surface.

51. E. PUSILLUM Torr. & Gray. [*E. comosum* (M. E. Jones) M. E. Jones var. *playanum* M. E. Jones. *E. reniforme* Torr. & Frém. ssp. *pusillum* (Torr. & Gray) S. Stokes. *E. r.* var. *playanum* (M. E. Jones) S. Stokes.] Spreading herbaceous annuals 0.5--3 dm high; leaves oblong-ovate to rounded, 0.5--2 (3) cm long, 0.4--2 (2.5) cm wide, densely tomentose below, floccose to subglabrous and greenish-yellow above, the hairs infrequently glandular, the petiole 1--3 cm long; stems slender, 1--8 cm long, glabrous except for scattered glands at the base in some; inflorescences open, spreading, 0.5--2.5 dm long and across, glabrous throughout; peduncles slender, 1--3.5 (4) cm long, spreading to ascending, glabrous; involucres broadly turbinate to campanulate, 1--1.5 (1.7) mm long, 1.5--3 mm wide, glandular without, 5-toothed; flowers yellow and 1--1.7 mm long in anthesis, becoming reddish-yellow and 2--2.5 mm long in fruit, glandular without, the tepals dimorphic, those of the outer whorl oblong-elliptic to obovate, those of the inner whorl oblong; achenes dark brown, 0.6--0.8 mm long. -- Infrequent to weedy and common in sandy to gravelly places from se. Ore. and sw. Ida. s. to s. Calif., and e. across s. Nev. to sw. Utah and w. Ariz.; known from nw. Mohave Co. and Walnut Canyon, Coconino Co., Ariz. Mar-Jul (Aug).

52. E. RENIFORME Torr. & Frém. [*E. r.* var. *comosum* M. E. Jones. *E. c.* (M. E. Jones) M. E. Jones.] Spreading herbaceous annuals 0.5--4 dm high; leaves round to reniform, 5--20 mm long and wide, tomentose below, tomentose to subglabrate and greenish above, the petiole 0.5--6 cm long; stems slender, 2--8 cm long, glabrous except for scattered hairs at the base; inflorescences open, spreading, 0.5--3.5 dm long, glabrous; peduncles slender to capillary, 3--15 mm long, glabrous; involucres broadly turbinate to subcampanulate, 1.5--2 (2.5) mm long and wide, glabrous without, 5-toothed; flowers yellowish to yellowish-red, 1--2 mm long, glandular without, the tepals slightly dimorphic, those of the outer whorl broadly ovate, those of the inner whorl oblong; achenes brown, 0.8--1 mm long. -- Locally common to infrequent from s. Calif. and s. Nev. s. to w. Ariz.; in widely scattered locations in Mohave and Yuma cos., Ariz. Mar-Jun (Aug).

The usual distinction between *Eriogonum pusillum* and *E. reniforme* is in the pubescences of the involucre; in the former, the involucre is glandular without, while in the latter it is glabrous. This is a constant and easily observed feature, but others are present as well. For example the leaves of *E. reniforme* are covered with a dense, wooly tomentum, while in *E. pusillum* the tomentum is not as thick nor as wooly. The stems of the former tend to be reddish and are several from the base of the plant, and spread outwardly in a gentle arc, while in the latter the stems are usually yellowish-green and usually only one which is erect. Attempts to include both within a single species cannot stand as even in mixed populations (as seen in southern Nevada), the two remain distinct and no hybrids have ever been observed.

53. E. WETHERILLII Eastw. [*E. sessile* Stokes ex Jones. *E. filiforme* L. O. Williams.] Low spreading herbaceous annuals 0.5--2.5 dm high; leaves oblong to orbicular, (0.5) 1--4 cm long, (0.5) 1--3 cm wide, densely tomentose below, floccose to subglabrous above, the petiole 1--5 cm long; stems slender, 1--5 cm long, glabrous except for villous bases in most; inflorescences compact and densely branched, 0.5--2 dm high, up to 4 dm across, the numerous branches becoming dark red with age, glabrous; peduncles filiform, erect, (3) 5--10 mm long, becoming shorter or lacking in the upper nodes in some, glabrous; involucres turbinate, (0.3) 0.5--1 mm long and wide, 4-toothed; flowers yellow to red, 0.6--1.2 mm long in anthesis, becoming pinkish to rose or red and 1--1.5 mm long in fruit, glabrous, the tepals elliptic to obovate; achenes brown to black, 0.6--1 mm long. -- Common and occasionally weedy in deep sandy soil in se. Utah, w. Colo., nw. N.M. and n. Ariz.; Coconino Co., Ariz., e. to San Juan Co., N.M. (Apr) Jul-Sep (Oct).

54. E. SUBRENIFORME S. Wats. [*E. filicaule* S. Stokes.] Tall to slightly spreading, erect herbaceous annuals 0.5--4 (6) dm high; leaves orbicular to reniform, (0.5) 1--3.5 cm long, (0.5) 1--4 cm wide, tomentose below in nearly straight hairs, hirsute to floccose or glabrous above, the petiole (1) 2--6 cm long; stems slender to

stoutish, 2--15 (20) cm long, glabrous except for the hispid bases; inflorescences open to ± diffuse, 0.5--4 dm long, up to 5 dm across, glabrous throughout; peduncles filiform, 0.5--2.5 cm long, glabrous; involucres turbinate, 0.5--1 mm long, 0.6--0.9 mm wide, glabrous without, 5-toothed; flowers white to rose, 0.8--2 mm long, glabrous or sparsely hirsute without, the tepals lanceolate to spatulate or elliptic to ovate; achenes light brown, 1.7--2 mm long. -- Infrequent and usually local on clay hills and slopes from s. Utah s. to n. Ariz. and disjunct into nw. N.M.; extreme ne. Mohave Co. and adjacent nw. Coconino Co., Ariz., and from central Apache Co., Ariz. e. to w. McKinley Co., N.M. Apr-Aug (Sep).

The distribution of this species is divided into two discrete units. The largest unit extends across southern Utah from Washington Co. to western San Juan Co., and northward to Garfield Co., and southward into northwestern Arizona in northeastern Mohave and adjacent northwestern Coconino cos. The smaller unit occurs in central Apache Co., Arizona, and extends into western McKinley Co., New Mexico. I have not detected any differences between the two units.

A related species, *Eriogonum viscidulum* J. T. Howell, known only from sandy hills near Bunkerville, Clark Co., Nevada, may be eventually found in northwestern Arizona. It has viscid stems and branches, and yellow flowers 1.3--2 mm long. It is rare and considered "endangered" in its present location.

55. E. ABERTIANUM Torr. in Emory. Low to tall or spreading sparsely to profusely branched herbaceous annuals 0.5--6 dm high; leaves basal and cauline, the basal leaf-blades oblong to ovate, 1--4 cm long, 1--3 cm wide, villous to hoary on both surfaces, the petiole 0.5--6 cm long, the cauline leaf-blades linear, lanceolate, or narrowly obovate, similar to the basal leaves only sessile or nearly so; stems prostrate to erect, appressed-hirsute throughout, usually leafy; inflorescences open to compact, 0.5--4 dm long, hirsute; bracts semifoliaceous, 3--6, linear to linear-lanceolate, 2--10 mm long, 1--3 mm wide; peduncles, when present, slender, ascending to erect, 0.5--6 cm long, villous to hoary throughout; involucres broadly campanulate, the involucral tubes 2--3 mm long with 5 oblong lobes 4--6 mm long and 1--2 mm wide, these usually reflexed, villous-canescent; flowers white to reddish or rose, 3--4.5 mm long, glabrous, the tepals dimorphic, those of the outer whorl orbicular-cordate, 1.8--3 mm long, 2--4 mm wide, those of the inner whorl lanceolate to spatulate, 3--4.5 mm long, 0.7--1.2 mm wide; achenes brown to dark brown, 1--1.6 mm long. -- Widespread and common from central and s. Ariz., central and s. N.M., and w. Tex. s. into Sonora, Chihuahua, and Coahuila, Mex., s. to San Luis Potosí, Mex.; common and often weedy in the s. half of Ariz. and N.M. (Mar) Apr-Oct (Dec).

To say this species is highly variable is an understatement. It is not only highly variable in terms of general gross morphology, it is even highly variable in terms of its growth pattern during the growning season so that at one time of the year it may be

a low, spreading, densely villous or hoary plant as in the spring of the year, whereas the same plant will be a tall, open, sparsely branched plant with little hair in the fall of the year. I am not as yet satisfied with my current division of the species into infraspecific units. The two variants occur together, do not seem to form hybrids, and behave as distinct species. However, until the plants are fully mature, it is impossible to distinguish the two variants! The var. *abertianum*, as defined here, may ultimately be divided into two variants, the typical form, and a second characterized by the type of *Eriogonum abertianum* var. *ruberrimum*. I am reluctant to make such a division for I simply do not know how to distinguish between the two except as to a "gestalt" I have developed as a result of field work. My concept of the species, as expressed in a review of the species in Texas (Reveal 1968c), has changed to a point that allows for the recognition of two forms, but in herbaria (ca 1968--1973), I called var. *cyclosepalum* (as recognized here) incorrectly var. *ruberrimum*, not realizing that the type of that plant was actually a form closer to var. *abertianum* than to the plants I was so labelling this name. Much more field and herbarium work is needed on this species.

VAR. ABERTIANUM. [*E. a.* var. *neomexicanum* Gandoger. *E. a.* var. *ruberrimum* Gandoger. *E. pinetorum* Greene. *E. a.* ssp. *p.* (Greene) S. Stokes. *E. a.* var. *villosum* Fosberg. *E. a.* var. *gillespiei* Fosberg. *E. cyclosepalum* Greene var. *g.* (Fosberg) I. M. Johnston.] Mature plants paniculately branched in the upper inflorescences; peduncles not axillary; bracts small and inconspicuous so that mature plants do not appear to be leafy in the upper inflorescences. -- Widespread and common from central Ariz. and N. M. s. to n. Mex. and extreme w. Tex.; common throughout Ariz. in all but the n. cos., and in N.M. in all but the n. tier of cos. (Feb) Mar-Oct (Dec).

As here defined, var. *abertianum* is composed of two elements. The typical phase is an erect, open plant with long peduncles which are more than 1 mm long, and a flower that is usually cream-colored and not reddish. The var. *ruberrimum* phase, in a strict sense, is a strict, erect plant with peduncles less than 1 mm long, and flowers which are usually reddish. In both cases, it should be noted, the bracts are small, and the inflorescence in paniculately branched. The typical phase is common in central New Mexico and nearly all of Arizona, but gives why to the *ruberrimum* phase in a gradual series of steps in southern New Mexico and in Cochise Co., Arizona. In northern Mexico (and parts of southern New Mexico), these two phases are distinct and readily separated in fruit. The immature stages are impossible to separate as of this writing.

VAR. CYCLOSEPALUM (Greene) Fosberg. [*E. c.* Greene. *E. lappulaceum* Greene. *E. a.* ssp. *c.* (Greene) S. Stokes. *E. a.* ssp. *l.* (Greene) S. Stokes. *E. a.* var. *l.* (Greene) Fosberg. *E. a.* var. *bracteatum* Fosberg.] Mature plants in erect strict, non-paniculate branching in the upper inflorescences; peduncles axillary;

bracts large and conspicuous so that mature plants appear leafy in the upper inflorescences. -- Widespread and common from s. N.M. and extreme se. Ariz. e. to w. Tex. s. to San Luis Potosí, Mex.; s. two tiers of cos. in N.M. and extreme se. Ariz. (mainly Cochise Co.). (Feb) Mar-Oct (Dec).

This is the appressed, leafy phase with usually sessile involucres, reddish to yellowish flowers, and a stiff, erect appearance (in some) or a low, spreading and nearly matted aspect (as in the plants of most of Mexico and Texas) which branch from the base. The zone of overlap between these two varieties, as recognized here, is in southern New Mexico (especially in Dona Aña Co.) and in southeastern Arizona. Once again, I have not been able to establish a set of clear criteria for distinguishing the plants of these varieties when they are immature or in early anthesis. The several varieties proposed by Fosberg (1938) have been tentatively segregated on the basis of the distribution of the mature plants.

56. E. PHARNACEOIDES Torr. in Sitgr. Erect herbaceous annuals 1--5 dm high; leaves basal and cauline, the basal leaf-blades linear-lanceolate to linear-oblanceolate, (1) 2--4 cm long, 1--4 mm wide, lanate below, villous and greenish above, the petiole 1--5 mm long, the cauline leaf-blades linear, 0.5--2.5 cm long, 0.5--3 mm wide, tomentose below, thinly villous to glabrous above, sessile; stems erect, villous, leafy; inflorescences open, 0.5--4.5 dm long, villous throughout; bracts semifoliaceous, 3--8, linear, (3) 5--15 mm long, 0.3--1.5 (2) mm wide; peduncles slender, erect or nearly so, (1) 2--5 (7) cm long, sparsely villous to glabrous; involucres campanulate, the involucral tubes 1--2 mm long, 2--3 mm wide, with 5 lanceolate lobes 1--3 mm long and 0.5--1 mm wide, these erect or nearly so, villous; flowers white to rose or yellow, 1--3 mm long, glabrous, the tepals dimorphic, those of the outer whorl oblong-ovate with two large saccate parts developing at the base of each tepal, those of the inner whorl linear-oblong and not forming saccate bases; achenes brown to blackish, 1.8--2 mm long. -- Widespread and rare to common mainly in sandy to gravelly places from se. Nev. and sw. Utah. se. across Ariz. to sw. N.M.; Mohave and Coconino cos. se. through Yavapai Co. to all other cos. except Yuma, and in sw. N.M. from Catron and Socorro cos. s. to Hidalgo Co. Jul-Oct.

There are two variants of this species in our area. The typical form is widespread and relatively common, while the var. *cervinum* is known only from Mohave Co., Arizona.

VAR. PHARNACEOIDES. [*E. arizonicum* Gandoger, non Stokes ex Jones, see number 33 of this treatment.] Flowers white to cream. Widespread throughout the range of the species in Ariz. and N.M. Jul-Oct.

VAR. CERVINUM Reveal. Flowers yellow. -- Rare and local, Lincoln Co., Nev. e. to Washington, Iron and Millard cos., Utah, s. to Mohave Co., Ariz.; known only from Mt. Trumbull, Mohave Co., Ariz.

Jul-Sep.

The var. *cervinum* was only recently described (Reveal 1974b) but has been known since the 1890s. My Arizona record is based on *Merkle & Merkle 930* (GCNP).

57. E. MACULATUM Heller. [*E. angulosum* Benth. var. *m.* (Heller) Jeps. *E. a.* ssp. *m.* (Heller) S. Stokes.] Low spreading herbaceous annuals 1--2 (3) dm high; leaves basal and cauline, the basal leaf-blades lanceolate to obovate, 1--3 (4) cm long, 1--1.5 (2) cm wide, tomentose below, floccose to glabrate above, the margin entire or crisped to slightly revolute in some, the petiole 0.5--1 cm long, the cauline leaf-blades lanceolate to oblanceolate, 0.5--2 cm long, 3--10 mm wide, otherwise similar to the basal leaves only sessile; stems slender, 2--8 cm long, mostly smooth or faintly angled in some, tomentose to floccose; inflorescences mostly open, spreading, 0.4--2.5 dm high and up to 3 dm across, tomentose to floccose throughout; peduncles filiform, spreading, (5) 10--30 mm long, often glandular-puberulent or glabrous; involucres campanulate, 1--1.5 (2) mm long, 1.5--3 (3.5) mm wide, glandular-puberulent without, 5-toothed; flowers white to yellow or pink to red with a large conspicuous rose to purple midrib spot, 1--2.5 mm long, glandular-puberulent without, the tepals dimorphic, those of the outer whorl elliptic to roundish or obovate with an inflated area at the base and the middle with the sides of the tepal incurved below, those of the inner whorl lanceolate to obtuse and extending beyond the apex of the outer tepals; achenes light brown, 1--1.5 mm long. -- Rather common and widespread from s. Wash. and s. Ida., s. in e. Calif. to extreme n. Baja Calif., Mex. and e. across Nev. to w. Utah and w. Ariz.; Mohave and Yavapai cos. s. to Yuma Co., and e. to Cochise Co., Ariz. Apr-Nov.

SUBGENUS OREGONIUM (S. WATS.) GREENE

58. E. DAVIDSONII Greene. [*E. baileyi* S. Wats. var. *d.* (Greene) M. E. Jones. *E. juncinellum* Gandoger. *E. molestum* S. Wats. var. *d.* (Greene) Jeps. *E. vimineum* Dougl. ex Benth. ssp. *j.* (Gandoger) S. Stokes. *E. v.* var. *d.* (Greene) S. Stokes.] Rather tall and erect herbaceous annuals 1--2 (3) dm tall; leaves mostly reniform to round, 1--2 cm long and wide, densely white-tomentose below, floccose to glabrate above, the petiole 1--3 cm long; stems erect, slender, 0.5--1 dm long, glabrous; inflorescences rather strict, erect, 0.5--2.5 dm long, up to 3 dm wide, glabrous throughout; involucres cylindric-turbinate, (2.5) 3--4 (5) mm long, 1--2 mm wide, glabrous without, the 5 acute teeth 0.2--0.4 mm long; flowers white to pink, 1.5--2 mm long, glabrous, the tepals oblong-obovate to oblong, the inner tepals only slightly narrower; achenes brown, 2 mm long. -- Rare and local to common and occasionally weedy from s. Calif. s. to Baja Calif., Mex., and e. in n. Ariz. and sw. Utah; known from Mohave, Coconino, Yavapai, and Gila cos., Ariz. Apr-Sep.

In Arizona, this plant has been called either *Eriogonum vimineum* Dougl. ex Benth. (Kearney & Peebles 1951; McDougall 1973) or less frequently, *E. juncinellum* Gandoger. Recently, however, this plant has had the name *E. davidsonii* applied to it (Reveal & Munz 1968; Reveal 1973), and that appears to be the correct name for our material. *Eriogonum vimineum* itself is a Pacific Northwest species as it occurs from Washington and Idaho southward through eastern Oregon into northern California and northern Nevada. *Eriogonum davidsonii* seems to be a southern element restricted to the mountains of southern California and northern Baja California, Mexico, eastward into southwestern Utah and western Arizona. The first is a low, spreading plant with usually several stems from the base of the plant, while the latter is an erect, strict plant with usually only a single stem at the base. This species complex is particularly difficult in California where the problem is aggravated at the moment by undescribed species which are now confused with either of these two species. Once those undescribed species are proposed, the distinction between *E. vimineum* and *E. davidsonii* will become much more obvious.

59. E. NIDULARIUM Cov. [*E. vimineum* Dougl. ex Benth. ssp. *n.* (Cov.) S. Stokes.] Low to weakly erect herbaceous annuals (0.5) 1--3 dm high; leaves basal, rounded or nearly so, 0.5--2 cm long and wide, tomentose below, tomentose to floccose or rarely glabrous above, the petiole 1--3 cm long; stems spreading, 3--8 cm long, floccose, usually numerous from the base; inflorescences dense, forming compact masses of numerous floccose branches 3--28 cm long, the tips of these branches often curving inwardly so as to form an inverted haystack; involucres turbinate, 1 mm long, 0.5--0.7 mm wide, floccose without, scattered along the branches and closely appressed to the stem, the 5 acute teeth 0.2--0.4 mm long; flowers yellow to reddish-yellow, 1.5--2 (3) mm long, glabrous, the tepals dimorphic, those of the outer whorl broadly fan-shaped, those of the inner whorl narrower and remaining erect; achenes brown, 1 mm long. -- Locally common in widely scattered locations in the deserts of w. Utah and Ariz. w. across s. Nev. to e. Calif., then n. along the w. edge of Nev. to se. Ore. and sw. Ida.; known only from Mohave Co., Ariz. Apr-Oct.

This is a distinct and clearly marked species of *Eriogonum* which cannot be readily confused with any other taxon, especially in Arizona. The densely compact stems and branches, coupled with the yellowish to yellowish-red flowers in small, tightly appressed involucres make it easy to distinguish at any time of the year. In Arizona, it is restricted to Mohave Co.

60. E. PALMERIANUM Reveal in Munz. [*E. plumatella* Dur. & Hilg. var. *palmeri* Torr. & Gray, non *E. palmeri* S. Wats. *E. baileyi* S. Wats. var. *tomentosum* S. Wats.] Low spreading herbaceous annuals 1--3 dm high; leaves basal, suborbicular to cordate, 0.5--1.5 cm long, 0.5--2 cm wide, densely tomentose below, less so to glabrate above, the petiole 1--4 cm long; stems open and spreading,

3--8 cm long, floccose to tomentose, one to few from the base; inflorescences open, forming loose spreading crowns of few floccose to tomentose branches, 0.5--2.5 dm long, up to 3 dm across, the tips of the branches spreading outwardly, not curving inwardly at all; involucres campanulate, 1.5--2 mm long and wide, floccose to tomentose without, only a few scattered along the branches and closely appressed to the stem, the 5 acute teeth 0.4--0.7 mm long; flowers white to pink, 1.5--2 mm long, glabrous, the tepal slightly dimorphic, those of the outer whorl narrowly fan-shaped, those of the inner whorl slightly narrower and erect; achenes brown, 1.5--1.8 mm long. -- Locally common and widespread from s. and e. Calif. e. across s. Nev. to s. and w. Utah, and into extreme sw. Colo. s. across most of Ariz. into w. N.M.; widespread in all cos. of Ariz. except Navajo, Apache, and Yuma, and known presently only from Grant and Hidalgo cos., N.M., but to be expected in Catron. Jun-Oct.

Since this species was proposed (Reveal & Munz 1968), some confusion has developed over its definition. In large part this is due to the long, and well-established misapplication of the name *Eriogonum densum* Greene which was wholly misunderstood by Stokes (1936, and herbaria annotations) and thus past on to Kearney and Peebles (1951) in the Arizona literature. In California, Jepson (1913) misapplied the name *E. baileyi* var. *tomentosum* in that he applied the name to two distinct elements, one applies to the type of var. *tomentosum* which I am now calling *E. palmerianum*, and a second which applies to the tomentose phase of *E. baileyi*, which I am now calling *E. baileyi* var. *divaricatum* (Gandoger) Reveal (or *E. commixtum* Greene if one wishes to use a specific name). Munz and Keck (1959) continued the confused application of the name in their flora of California, and more recently, Howell (1976) followed this point of view. McDougal (1973) has gone so far as to place both *E. nidularium* and *E. palmerianum* under *E. densum*, but based upon his description he is including only the first two elements in his treatment as the description does not apply to *E. densum* in any fashion. To resolve this confusion, hopefully once and for all, the following discussion is appended here:

Eriogonum nidularium may be quickly distinguished from *E. densum* and *E. palmerianum* by flower color. In this species, the flowers are yellowish to yellowish-red (except for a single pale-yellow flowered population discovered in Nye Co., Nevada). Also, the outer tepals are broadly fan-shaped and of a much broader width than the inner tepals. The upper branches tend to bend inwardly at the top, and in larger plants, the stems and branches are so numerous that the plants appear as a single, compact mass.

Eriogonum palmerianum is white-flowered, and the tepals are only narrowly fan-shaped, that is, the upper portion of the tepal blade is not as expanded as that seen in *E. nidularium*. Likewise, the size difference between the outer and inner tepals of *E. palmerianum* is not as pronounced. The upper branches of this species are never incurved nor so massed as to form a dense crown. Rather

the branches are few in number, open and generally spreading at all angles to give the plants a less organized appearance. The branches are generally gently curved and usually more stout than those seen in *E. nidularium*. *Eriogonum palmerianum* also differs from *E. nidularium* in having longer involucres and achenes, but generally shorter flowers.

Eriogonum baileyi var. *divaricatum* is not related to either of the two species discussed above. However, as it has been confused with *E. palmerianum*, it is necessary to discuss it briefly. First, the flowers of var. *divaricatum* are glandular-puberulent without, and the tepals are not fan-shaped. The pubescent stems are covered with a thinner tomentum that is more grayish than the grayish-brown color seen in *E. palmerianum* or the reddish-brown of *E. nidularium*. The involucres of var. *divaricatum* are turbinate and not campanulate as in *E. palmerianum*, and the involucres are restricted to well-defined nodes. Also, the branching pattern of the variety is similar to the open, spreading and generally upright pattern of *E. baileyi* and thus with straight branch segments instead of the random, curving branch pattern of *E. palmerianum*.

Eriogonum densum is more closely related to *E. polycladon* Benth. in DC. than to either *E. nidularium* or *E. palmerianum*. It is a low, dense plant with numerous stems and branches arising from the base of the plant, but unlike *E. nidularium*, the branches are very short and straight, and are much more slender. The flowers are white, with the outer tepals broadly fan-shaped and thus much broader than the tepals of the inner whorl. In this regard, the flower is more similar to that of *E. nidularium* than that of *E. palmerianum*. The leaves of this species differ from the other two in that they are elliptic to oblanceolate instead of rounded. The tomentum of *E. densum* is blackish-gray. The involucres of *E. densum* are turbinate and shorter than those of *E. palmerianum* which are campanulate.

The distribution of the four taxa discussed here is fairly distinct, with overlap minimal in all states but Nevada. I have seen no hybrid populations in the field, but must admit that some herbarium material of *Eriogonum nidularium* and *E. palmerianum* is difficult to distinguish. I have had no difficulty is recognizing *E. baileyi* var. *divaricatum* or *E. densum*.

Eriogonum nidularium occurs from eastern Oregon and southwestern Idaho southward through eastern California and the western half of Nevada to about Inyo Co., California, where the species becomes much more abundant, and then ranges southward in California to Riverside Co., and eastward across Clark, Nye and Lincoln cos., Nevada, to Washington Co., Utah, and western Mohave Co., Arizona.

Eriogonum palmerianum ranges in California from Riverside Co. northward to Mono Co., and then drifts into Nevada where it is found from Esmeralda Co. northward through Churchill Co. to Humboldt Co., and then eastward (and much more abundant) across Nye, Clark and Lincoln cos., Nevada, to the western tier of counties in Utah (from Box Elder Co. south to Washington Co.), and across southern Utah to extreme southwestern Colorado. In Arizona, the

species occurs in Mohave and Coconino cos., southward to Yavapai and Gila cos., and then becomes gradually less common as one proceeds across Maricopa, Pima, Pinal, and Graham cos., into Cochise Co. My New Mexico records are restricted to Grant and Hidalgo cos. The degree of overlap between this species and *E. nidularium* is not great in Arizona and New Mexico (only Mohave Co.), but it is much more extensive in southern Nevada and adjacent southeastern California.

Eriogonum baileyi var. *divaricatum* is restricted to a small area in east-central California and adjacent west-central Nevada. My records show the variant to be rare from Lassen Co. southward to northern Inyo Co. in California, but more common in Washoe, Storey, Ormsby, Douglas and Humboldt cos., Nevada. It is to be excepted in Churchill, Lyon, and Pershing cos. as well. I have collected all three taxa that occur in this part of Nevada on several occasions, and no hybrids or confusing populations have been discovered.

Eriogonum densum, the real troublemaker in this complex, is known to me only from the type and one other collection, both from the Silver City area of Grant Co., New Mexico. The last collection of this taxon was made in 1903. To my knowledge, this species is restricted to the mountains in the Silver City area, and is not found outside New Mexico's Grant Co.

The distinction of the three species, *Eriogonum nidularium*, *E. palmerianum*, and *E. densum* is not difficult if one ignores the several errors made by past authors, and reviews the types of the taxa involved. The type of the first was collected in Inyo Co., California, while that of the second (*E. plumatella* var. *palmeri*) was gathered somewhere in Arizona. The type of the last, as already noted, was gathered near Silver City, New Mexico. Stokes (1936) simply did not understand these types to any great degree, and caused the difficulties now found in the literature. Hopefully now, the confusion can end.

61. E. DENSUM Greene. [*E. vimineum* Dougl. ex Benth. var. *d.* (Greene) S. Stokes.] Low spreading herbaceous annuals 0.5--1.5 dm high; leaves subbasal, elliptic to oblanceolate, 0.3--1 cm long, 2--7 mm wide, tomentose on both surfaces, usually somewhat less so above, the petiole 3--5 mm long; stems spreading, (1) 3--5 mm long, tomentose, numerous from the base; inflorescences dense, forming compact masses of numerous slender, floccose branches 0.5--1.2 dm long, the tips of the branches straight, not curved; involucres turbinate, 1--1.5 mm long, 0.7--1.2 mm wide, subglabrous without, scattered along the branches and appressed to them in the forks of the numerous nodes, the 5 acute teeth 0.4--0.6 mm long; flowers white, 1--1.5 mm long, glabrous, the tepals dimorphic, those of the outer whorl broadly fan-shaped, those of the inner whorl narrower and just slightly longer; achenes brown, 1--1.2 mm long. -- Rare and perhaps extinct, known only from Grant Co., N.M., in the Silver City area. Jun-Oct.

Little needs to be added to the discussion that has already

been presented under *Eriogonum palmerianum*. I have regarded this species as "endangered" and have so informed the Fish and Wildlife Service's Office of Endangered Species. Besides the type, the other collection that has been available to me is *Metcalfe 840*.

62. E. POLYCLADON Benth. in DC. [*E. p.* var. *mexicanum* Gandoger. *E. p.* var. *crispum* Gandoger. *E. vimineum* Dougl. ex Benth. ssp. *p.* (Benth. in DC.) S. Stokes.] Erect herbaceous annuals 1--6 (10) dm high; leaves cauline, narrowly oblanceolate to broadly elliptic, 1--3 cm long, 0.5--2 cm wide, densely tomentose below, only slightly less so above, the petiole 3--15 mm long; stems erect, slender, 1--3 dm long, tomentose; inflorescences narrow, strict, 1--5 (8) dm long, tomentose throughout; involucres turbinate, 1.5--2.5 mm long, 1--1.5 mm wide, tomentose to glabrous without, scattered along the branches and closely appressed, the 5 acute teeth 0.2--0.5 mm long; flowers white to pink, 1.5--2 mm long, glabrous, the tepals dimorphic, those of the outer whorl broadly fan-shaped and becoming strongly reflexed outwardly, those of the inner whorl narrower and remaining erect; achenes dark brown, 1--1.3 mm long. -- Rare to infrequent or rarely common and weedy from s. Utah s. into Ariz. and N.M. s. into w. Tex. and n. Mex.; Mohave and Coconino cos. se. through Yavapai Co. to Graham, Greenlee, and Santa Cruz and Cochise cos., Ariz., and in N.M. from Sandoval and Santa Fe cos. s. Jul-Oct (Dec).

This is a common species in widely scattered areas especially in the northern part of its range. It is much more common in the southern half of Arizona and New Mexico than in the northern half.

63. E. DIVARICATUM Hook. Low spreading herbaceous annuals 1--2 (3) dm high; leaves basal and cauline, the basal leaf-blades elliptic-oblong to orbicular, 1--3 cm long, 1--2 cm wide, puberulent to short pilose on both surfaces, the petiole 2--4 cm long, the cauline leaf-blades similar but becoming gradually reduced in size above; stems spreading to decumbent or prostrate, 3--5 cm long, puberulent, leafy; inflorescences spreading, often decumbent and spreading along the ground, 0.5--2.5 dm long, puberulent; involucres turbinate, 1--2 mm long, 0.7--1.2 mm wide, pilose, the 5 lanceolate lobes 0.7--1.8 mm long, dividing the tube nearly to the base; flowers yellowish, 1.5--2 mm long, hispidulous or glandular without, the tepals mostly oblong, those of the inner whorl just slightly narrower; achenes light brown, 1.5--1.8 mm long. -- In widely scattered locations on clay hills and slopes from e. Utah and sw. Wyo. s. through w. Colo. to nw. N.M. and n. Ariz.; Coconino, Navajo, and Apache cos., Ariz., and San Juan, Sandoval, and McKinley cos., N.M. Jun-Sep (Oct).

64. E. PUBERULUM S. Wats. [*E. p.* var. *venosum* S. Stokes.] Low spreading herbaceous annuals 0.5--3 dm high; leaves basal, obovate to rounded, 0.5--1.5 cm long and wide, sparsely villous on both surfaces, the petiole 0.5--2 cm long; stems erect or spreading, 3--8 cm long, silky-puberulent; inflorescences spreading,

0.5--2.5 dm long, silky-puberulent, often with highly reduced, bractlike leaves at the lower nodes; involucres turbinate, 1--1.5 mm long, 0.6--1 mm wide, villous without, the 4 oblong lobes dividing the tube nearly to the base; flowers white to red, 1--1.5 mm long, glabrous or hispidulous without, the tepals slightly dimorphic, those of the outer whorl obcordate, those of the inner whorl narrower; achenes light brown, 1 mm long. -- Infrequent and widely scattered in sw. Utah and se. Nev.; not known from Ariz. but to be expected in extreme ne. Mohave or nw. Coconino cos. Jun-Aug.

Kearney and Peebles (1951) felt that this species should be found eventually in Arizona, and I can see no immediate reason why it should not be found there. As yet, however, no specimens have been seen from Arizona.

65. E. DARROVII Kearney. Low spreading herbaceous annuals 0.3--1.5 dm high; leaves basal and cauline, the basal leaf-blades obtuse, 0.6--1.2 (1.5) cm long, 0.5--1 (1.3) cm wide, sericeous and green on both surfaces, the petiole 0.5--1.5 cm long, the cauline leaf-blades similar to the basal leaves only becoming gradually reduced in size upwardly; stems spreading to weakly erect, 3--5 cm long, sericeous and green throughout; inflorescences dense and compact with numerous sericeous branches 0.3--1.2 dm long; involucres turbinate-campanulate, 2--2.5 mm long, 1.5--2 mm wide, sericeous without, the elliptic lobes 1--1.3 mm long, 0.4--0.6 mm wide, sericeous; flowers pale yellow to pinkish, 1.5--2 mm long, white-hirtellous, the tepals strongly dimorphic, those of the outer whorl fan-shaped and hooded, those of the inner whorl lanceolate and erect, usually longer than the tepals of the outer whorl; achenes brown, 1 mm long. -- Local and usually rare in Coconino Co., Ariz., and White Pine Co., Nev. Jul-Sep.

This rare species was first collected south of Major's Place along U. S. Highway 93 by Ripley and Barneby (*6316* - CAS), but the plants were so immature, that they were not recognized as a unique species, and in fact were reported by Barneby (1947) as *Eriogonum divaricatum*. The type of *E. darrovii* was collected in 1945 and described by Kearney (1946) a year later. More recently, the species has been collected near Slide Tank, and Dr. N. Duane Atwood of the Bureau of Land Management in Utah, has recollected this species in Coconino Co. where it is restricted to the northern edge of the Kaibab Plateau. I have regarded this species as "endangered" as the Nevada population is restricted to a single limestone outcrop, and the Arizona populations, according to Atwood, are subject to disruption by logging, road building, and grazing pressures on the Kaibab Plateau.

EXCLUDED SPECIES

Eriogonum flexum M. E. Jones = *Stenogonum flexum* (M. E. Jones) Reveal & Howell. In a recent review of the genera of the subfamily Eriogonoideae, Reveal and Howell (1976) have excluded

this species from *Eriogonum* and placed it in the genus *Stenogonum*. *Stenogonum* will be discussed in a forthcoming paper by Reveal and Ertter (in press).

Eriogonum nemacaulis S. Stoles = *Nemacaulis denudata* Nutt.

Eriogonum perfoliatum (Torr. & Gray) S. Stokes = *Oxytheca perfoliata* Torr. & Gray.

Eriogonum salsuginosum (Nutt.) Hook. = *Stenogonum salsuginosum* Nutt.

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The following list of names is supplied to all entities mentioned in this treatment. Names in **bold face** are acceptable names and the number is the number of the species in this treatment at which the taxon is formally treated; those in *italics* are synonyms or the number of the taxon (taxa) where a particular named is discussed but not otherwise treated. New taxa are indicated in CAPITAL LETTERS.

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Copies of this publication can be obtained, at cost, from the Department of Botany, University of Maryland, College Park, Maryland, 20742.

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NOTES ON NEW AND NOTEWORTHY PLANTS. XCIII

Harold N. Moldenke

AVICENNIA SCHAUERIANA f. GLABRESCENS Moldenke, f. nov.

Haec forma a forma typica speciei laminis foliorum ubique glabratis recedit.

This form differs from the typical form of the species in having both surfaces of its leaf-blades glabrate.

The type of the form was collected by Captain Reginald Charles Marshall (Herb. Trin. Bot. Gard. 12651) in the Caroni Swamp, Trinidad, on May 9, 1932, and is deposited in the Britton Herbarium at the New York Botanical Garden.

PAEPALANTHUS SESLERIOIDES var. CARABIAE Moldenke, var. nov.

Haec varietas a forma typica speciei statura minima foliis 1—3 cm. longis pedunculis 2.5—6.5 [—8] cm. longis recedit.

This variety differs from the typical form of the species in its much smaller stature, the leaves mostly only 1—3 cm. long and the peduncles usually only 2.5—6.5 cm. long, occasionally to 8 cm. long.

The type of the variety was collected by José Perez Carabia (no. 3941) on the Sabanas de los Indios, Isla de Pinos, Cuba, on May 11, 1940, and is deposited in the Britton Herbarium at the New York Botanical Garden.

PAEPALANTHUS SESLERIOIDES var. WILSONII Moldenke, var. nov.

Haec varietas a forma typica speciei statura perspicue parviora foliis 4.5—6.5 cm. longis pedunculis 8—20 cm. longis recedit.

This variety differs from the typical form of the species in its conspicuously smaller stature, the leaves mostly 4.5—6.5 cm. long and the peduncles mostly 8—20 cm. long.

The type of the variety was collected by Nathaniel Lord Britton, Elizabeth Gertrude Britton, and Percy Wilson (no. 14225) in white sand in the vicinity of Los Indios, Isla de Pinos, Cuba, on February 13, 1916, and is deposited in the Britton Herbarium at the New York Botanical Garden.

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ADDITIONAL NOTES ON THE ERIOCAULACEAE. LXIV

Harold N. Moldenke

ERIOCAULON ODORATUM Dalz.

Additional synonymy: Eriocaulon odoratum Moldenke, Phytologia

34: 274, in syn. 1976.

Additional bibliography: Moldenke, Phytologia 32: 503 (1976) and 34: 274. 1976.

Smitinand found this plant in flower and fruit in October.

Additional citations: THAILAND: Smitinand 4607 (Ac).

ERIOCAULON OREADUM Van Royen

Additional bibliography: Moldenke, Phytologia 32: 503 (1976) and 34: 267. 1976.

Additional citations: NEW GUINEA: Papua: Henty NGF.49668 (Z—photo, Z—photo).

ERIOCAULON OVOIDEUM Britton & Small

Additional bibliography: Moldenke, Phytologia 32: 504 (1976), 33: 12 (1976), and 34: 254. 1976.

ERIOCAULON PARAGUAYENSE Körn.

Additional bibliography: Holm, Bot. Gaz. 31: 18. 1901; Moldenke, Phytologia 32: 504. 1976.

ERIOCAULON PARKERI B. L. Robinson

Additional & emended bibliography: Gleason, New Britt. & Br. Illustr. Fl., imp. 1, 1: 372 & 373 (1952), imp. 1, 3: 562 & 568 (1952), imp. 2, 1: 372 & 373 (1958), imp. 2, 3: 562 & 568 (1958), imp. 3, 1: 372 & 373 (1963), and imp. 3, 3: 562 & 568. 1963; Bolkh., Grif, Matvej., & Zakhar., Chrom. Numb. Flow. Pl., imp. 1, 274 (1969) and imp. 2, 274. 1974; Moldenke, Phytologia 32: 504. 1976.

Additional & emended illustrations: Gleason, New Britt. & Br. Illustr. Fl., imp. 1, 1: 373 (1952), imp. 2, 1: 373 (1958), and imp. 3, 1: 373. 1963.

The Friell s.n. [April 9, 1969] and R. W. Hill s.n. [4/9/1969], distributed as E. parkeri, actually are Syngonanthus flavidulus (Michx.) Ruhl.

Additional citations: NEW YORK: Ulster Co.: House 25069 (Sd—31577). PENNSYLVANIA: Bucks Co.: Dreisbach s.n. [July 1, 1926] (Sd—23693).

ERIOCAULON PARVUM Körn.

Additional bibliography: Moldenke, Phytologia 29: 214. 1974.

The vernacular name, "kuro-hoshigusa", is reported for this species.

Additional citations: JAPAN: Shikoku: Collector undetermined s.n. [Sakawa, Tosa, Sept. 20, 1894] (W—248162).

ERIOCAULON PELLUCIDUM Michx.

Additional & emended bibliography: Holm, Bot. Gaz. 31: 18. 1901; Gleason, New Britt. & Br. Illustr. Fl., imp. 1, 1: 372 & 373 (1952), imp. 1, 3: 562 & 568 (1952), imp. 2, 1: 372 & 373 (1958), imp. 2, 3: 562 & 568 (1958), imp. 3, 1: 372 & 373 (1963), and imp. 3, 3: 562 & 568. 1963; G. W. Thomas, Tex. Pl. Ecolog.

Summ. 32 & 100. 1969; Bolkh., Grif, Matvej., & Zakhar., Chrom. Numb. Flow. Pl., imp. 1, 274 (1969) and imp. 2, 274. 1974; Greller, Bull. Torrey Bot. Club 102: 415. 1975; R. D. Wood, Hydrobot. Meth. 15. 1975; Moldenke, Phytologia 32: 504-505. 1976.

Additional & emended illustrations: Gleason, New Britt. & Br. Illustr. Fl., imp. 1, 1: 373 (1952), imp. 2, 1: 373 (1958), and imp. 3, 1: 373. 1963.

Thomas (1969) calls this the "seven-angle pipewort" and also reports "white buttons" and "duckgrass" [not to be confused with "duckweed" which is Lemna]. Greller (1975) found it in Suffolk County, New York. Sefton refers to it as having "tiny grasslike vegetative bodies submerged in 0.3 m. water with [the] fruiting structures sticking above [the] water, sandy bottom" and found it in fruit in September.

Additional citations: MAINE: Waldo Co.: Friesner 10224 (Sd—32293). NEW JERSEY: Ocean Co.: Moldenke & Moldenke 28550 (Ln). VIRGINIA: Augusta Co.: Killip 32582 (Sd—33948). WISCONSIN: Vilas Co.: Sefton 123 (Lc).

ERIOCAULON PERUVIANUM Ruhl.

Emended synonymy: Eriocaulon glabrum Pennell ex Moldenke, Résumé 288, in syn. 1959 [not E. glabrum Salzm., 1959, nor Steud., 1855].

Additional bibliography: Moldenke, Phytologia 32: 505. 1976.

ERIOCAULON POLYCEPHALUM Hook. f.

Additional bibliography: Moldenke, Phytologia 29: 219—220. 1974.

Maxwell encountered this species at 150 m. altitude, in fruit in May.

Additional citations: THAILAND: Maxwell 74-374 (Ac).

ERIOCAULON PSEUDOCOMPRESSUM Ruhl.

Additional bibliography: Moldenke, Phytologia 32: 505 (1976) and 33: 57. 1976.

ERIOCAULON PULCHELLUM Körn.

Additional bibliography: Moldenke, Phytologia 29: 220. 1974.

Additional citations: LIBERIA: J. T. Baldwin 9176 (W—2070088), 9800 (W—2070107, Z).

ERIOCAULON PYGMAEUM Soland.

Additional bibliography: Moldenke, Phytologia 32: 505—506. 1976.

Bailey reports finding this plant growing in "high damp land".

Additional citations: AUSTRALIA: Queensland: F. M. Bailey s.n. [Brisbane River] (W—45281).

ERIOCAULON QUINQUANGULARE L.

Additional bibliography: Moldenke, Phytologia 33: 9—10, 58, & 201 (1976) and 34: 262, 263, 274, & 402. 1976.

Additional citations: INDIA: Kerala: Stocks, Law, &c. s.n. [Malabar, Concan, &c.] (W--2500533). Mysore: G. Thomson s.n. [Maisor & Carnatic] (W--2501696). West Bengal: Mukherjee s.n. [16.7.74] (Ld).

ERIOCAULON QUINQUANGULARE var. MARTIANUM Wall.
Additional bibliography: Moldenke, Phytologia 29: 222 (1974) and 31: 397. 1975.

ERIOCAULON REDACTUM Ruhl.
Additional bibliography: Moldenke, Phytologia 24: 496. 1972.
Additional citations: INDIA: Kerala: Stocks, Law, &c. s.n. [Malabar, Concan, &c.] (W--2500532--isotype, W--2500544--isotype).

ERIOCAULON ROBINSONII Moldenke
Additional bibliography: Moldenke, Phytologia 24: 496--497. 1972.
Additional citations: INDOCHINA: Annam: Clemens & Clemens 3275 (W--1427432); C. B. Robinson 1043 (W--713307); Squires 91 (W--1379006).

ERIOCAULON ROBUSTIUS (Maxim.) Mak.
Additional bibliography: Moldenke, Phytologia 26: 462 (1973) and 34: 266, 393, & 396. 1976.
Recent collectors describe the flowers of this species as "light-brown" and the fruit "gray" and have found it in rice fields, flowering and fruiting in May and from August to October, reporting the common names, "hirohamohoshikusa" and "ō-hoshigusa". Tsang refers to it as "abundant in swamps, sandy soil of rice terrace 1 m. in diameter".
Material has been misidentified and distributed in some herbaria as E. alpestre Hook. f., E. alpestre Hook. f. & Thoms., E. buergerianum Körn., and E. formosanum Hayata. The Bohnhof 294 and Tsang 20687, cited below, were previously erroneously cited by me as E. buergerianum Körn.
Additional citations: CHINA: Kwangtung: Tsang 20687 (B, Cp, Ms, N, N, Ob, S, V--1838, V--4618, W--1753776). Manchuria: Bohnhof 294 (N, N). KOREA: Faurie 891 (W--2495297). JAPAN: Honshu: Collector undetermined s.n. [Shimura, Musashi, Oct. 20, 1893] (W--205477), s.n. [Musashi, Tabata, 27 Sept. 1910] (W--1310114); Hashimoto 850 (W--2188482); Kirino 418 (W--2276049); J. Matsumura s.n. [Tokio, October 5, 1879] (W--152096); Togasi 915 (W--2188535). FORMOSA: Tanaka & Shimada 13574 (W--1579788).

ERIOCAULON ROBUSTO-BROWNIANUM Ruhl.
Additional bibliography: Moldenke, Phytologia 33: 10--11. 1976.
Additional citations: INDIA: Mysore: Bogner 513 (Mu).

ERIOCAULON ROBUSTUM Steud.

Additional bibliography: Moldenke, Phytologia 29: 223. 1974.

Additional citations: INDIA: Madras: Perrottet s.n. [Nilgherris] (W—2494894).

ERIOCAULON SCARIOSUM J. E. Sm.

Additional & emended bibliography: Bolkh., Grif, Matvej., & Zakhar., Chrom. Numb. Flow. Pl., imp. 1, 274 (1969) and imp. 2, 274. 1974; Moldenke, Phytologia 33: 11. 1976.

Recent collectors have encountered this plant in swamps and at the edges of ponds, flowering and fruiting in October.

Additional citations: AUSTRALIA: New South Wales: F. M. Bailey s.n. [Brisbane River] (W—45304); Collector undetermined s.n. [near Sydney] (W—808562); J. Garden 17743 (W—2038350); Wilkes s.n. [New South Wales] (W—45305). Queensland: M. S. Clemens s.n. [March 1945] (Mi), s.n. [16 October 1946] (Mi).

ERIOCAULON SCHULTZII Benth.

Additional bibliography: Moldenke, Phytologia 33: 12 (1976) and 34: 402. 1976.

Chippendale describes this as an annual plant, 3—4 inches tall, with white inflorescences, and reports it common in sandy soil of woodlands "near monsoon forest", flowering and fruiting in May.

Additional citations: AUSTRALIA: Northern Territory: Chippendale 6162 (Z).

ERIOCAULON SEEMANNII Moldenke

Additional bibliography: Moldenke, Phytologia 33: 12 (1976) and 34: 252. 1976.

ERIOCAULON SELLOWIANUM Kunth

Additional bibliography: Holm, Bot. Gaz. 31: 18. 1901; Moldenke, Phytologia 33: 12—13 (1976) and 34: 260. 1976.

ERIOCAULON SELLOWIANUM var. LONGIFOLIUM Moldenke

Additional bibliography: Moldenke, Phytologia 33: 12—13. 1976.

Lindeman & Haas refer to this plant as a "rare herb" and found it growing at 1100 m. altitude. Haas and his associates describe the flowers as "white". Schinini & Carnevali encountered it "en bajo pantanoso", flowering in November.

Additional citations: BRAZIL: Goiás: Haas, Haas, & Belém 145 [Herb. Brad. 48648] (Ut—320410). Paraná: Lindeman & Haas 2965 (Ut—320402). ARGENTINA: Corrientes: Schinini & Carnevali 10314 (Ld).

ERIOCAULON SELLOWIANUM var. PARANENSE (Moldenke) Moldenke & Smith

Additional bibliography: Moldenke, Phytologia 33: 13. 1976.

Lindeman & Haas encountered this plant in the border zone of

marshes and describe the flower-heads as "white". They found it in flower and fruit in February.

Additional citations: BRAZIL: Paraná: Lindeman & Haas 4601 (Ld); Smith, Klein, & Hatschbach 15667 (W—2653316).

ERIOCAULON SETACEUM L.

Additional synonymy: Eriocaulon nutans F. Muell. ex R. Schomb., Fl. S. Austral. 62. 1875. Eriocaulon natans F. Muell. ex Moldenke, Phytologia 34: 273, in syn. 1976 [not E. natans Afzel., 1959].

Additional bibliography: R. Schumb., Fl. S. Austral. 62. 1875; Moldenke, Phytologia 24: 425 & 484 (1972), 33: 13—14 (1976), and 34: 263, 264, 274, 277, 278, & 406. 1976.

Maxwell encountered this plant floating in a shallow pool in an open marsh with sandy bottom, at 25 m. altitude, and describes it as having green leaves and white inflorescences. Specht describes it as an aquatic herb with gray floral heads and found it growing in "pH 6.5 pools at [the] base of sandstone hills", flowering and fruiting in June.

The E. natans and E. nutans, credited to Ferdinand Jacob Heinrich von Mueller, are apparently based on R. Schomburgk s.n. from the "North. coast" of Australia. The E. natans, credited to Afzelius, is a synonym of E. thunbergii Wikstr.

Material of E. setaceum has been misidentified and distributed as E. equisetoides Royen. On the other hand, the Göbel s.n. [1898/9], distributed as E. setaceum, seems better regarded as var. capillus-naiadis (Hook. f.) Moldenke, as does also C. Wright s.n. [Hong Kong].

Additional citations: SRI LANKA: Thwaites s.n. [Sept. 1864] (Sd—23692). THAILAND: Maxwell 73-387 (Ac). AUSTRALIA: Northern Territory: R. Schomburgk s.n. [North. coast] (W—45283); Specht 480 (W—2094729).

ERIOCAULON SETACEUM var. CAPILLUS-NAIADIS (Hook. f.) Moldenke

Additional bibliography: Moldenke, Phytologia 33: 14 (1976) and 34: 263 & 254. 1976.

Belcher encountered this plant in flooded paddy fields, flowering in October, and describes it as an "aquatic herb".

Material has been misidentified and distributed in some herbaria as Podostemon algaeformis Benth.

Additional citations: SRI LANKA: Göbel s.n. [1898/9] (Mu—66). BURMA: Upper Burma: Belcher 722 (W—2213211). HONG KONG: C. Wright s.n. [Hong Kong] (W—46452).

ERIOCAULON SETICUSPE Ohwi

Additional bibliography: Moldenke, Phytologia 26: 464. 1973.

Additional citations: JAPAN: Kyushu: Togasi 1415 (W—2316612).

ERIOCAULON SEXANGULARE L.

Additional & emended bibliography: Sonohara, Tawada, & Amano

[ed. E. H. Walker], Fl. Okin. 205. 1952; Bolkh., Grif, Matvej., & Zakhar., Chrom. Numb. Flow. Pl., imp. 1, 274 (1969) and imp. 2, 274. 1974; Moldenke, Phytologia 33: 14—15 (1976) and 34: 265 & 394. 1976.

Recent collectors describe this plant as an herb, 6 inches tall, with white or "whitish" inflorescence-heads, white stamens, and gray fruit. They encountered it in ditches, in open Melaleuca forests "on sandy podsolic soil", on wet sand at the edges of streams in tropical rain forests, and in wet seepage from paddy fields, flowering and fruiting in February. Lei refers to it as "abundant on moist gentle slope in sandy soil in meadow edge of field". Norton calls it "common" and Fosberg describes it as "locally common in grassy peat bog in broad ravine" and "locally common in marsh of cleared peat land being drained" in the Ryukyo Islands.

Geesink and Phenghklai report this plant "common in open places" at sealevel in Thailand. Sonohara and his associates (1952) record it, under the name E. miyagianum Koidz., from "wet soil in Kunigami, Ishigaki, Iriomoto, and Ihoya" in the Ryukyu Islands and list "ohshiratama-hoshikusa" as a Japanese vernacular name for it. They assert that E. miyagianum "is recognized by Satake and Moldenke", but I no longer recognize it as distinct from E. sexangulare.

Eriocaulon pterosepalum Hayata appears to be based on Kawakami & Sasaki s.n. [Herb. Taiwan 5563] of which there is a photograph in the United States National Herbarium at Washington.

Material of E. sexangulare has been misidentified and distributed in some herbaria as E. alpestre var. robustius Maxim. On the other hand, the Kasim bin Rajab 80, distributed as E. sexangulare, actually is E. australe R. Br., Collector undetermined s. n. [Wada-mura, Musashi, Oct. 30, 1893] and Thwaites C.P.795 are E. cinereum R. Br., Tsang 535 [Herb. Lingnan Univ. 16034] is E. truncatum Hamilt., Kasim bin Rajab 5124 is E. willdenovianum Moldenke, Flenley 41 is E. willdenovianum f. viviparum Moldenke, and Poore 956 is a mixture of E. willdenovianum and its f. viviparum.

Additional citations: SRI LANKA: Jayasuriya 1520 (W—2768304). CHINA: Fukien: J. B. Norton 1186 (W—1347914). Kwangtung: Levine & Groff 82 (W—778541). CHINESE COASTAL ISLANDS: Hainan: How & Chun 70286 (W—1669450); Lei 58 (W—1753849). HONG KONG: Taam 1547 (W—2063832, W—2244510); C. Wright s.n. [Hong Kong] (W—46454). THAILAND: Geesink & Phenghklai 6311 (Ac); Maxwell 71-565 (Ac). INDOCHINA: Annam: Clemens & Clemens 3301 (W—1427451). Cambodia: H. M. Smith 293 (W--1373123). MALAYA: Singapore: Nur s.n. [7th August 1925] (W—1349404). RYUKYU ISLAND ARCHIPELAGO: Ishigaki: F. R. Fosberg 37135 (W—2459389), 37830 (W—2459531). FORMOSA: Kawakami & Sasaki s.n. [Herb. Taiwan 5563] (W--photo); Nakahara s.n. [June 1905] (W—794982); Odashima s.n. [Tanaka &

Shimada 13575] (W—1700188).

ERIOCAULON SIKOKIANUM Maxim.

Additional bibliography: Sonohara, Tawada, & Amano [ed. E. H. Walker], Fl. Okin. 205. 1952; Moldenke, Phytologia 26: 25 & 39. 1973.

Sonohara and his associates (1952) record this species from "In wet soil in Kunigami......new to the flora of Okinawa" and list the Japanese vernacular name, "shiro-inunokige", for it.

The Collector undetermined s.n. [Wada-mura, Musashi, Sept. 6, 1893] & s.n. [Musashi, Shinako, 17 Sept. 1910] and E. Elliott 128, distributed as E. sikokianum, actually are E. nipponicum Maxim.

ERIOCAULON SMITINANDI Moldenke

Additional bibliography: Moldenke, Phytologia 25: 77. 1972.

Smitinand encountered this plant on savannas, at 150 m. altitude, where he found it to be "common", flowering and fruiting in December. He refers to it as a "white-flowered herb".

Additional citations: THAILAND: Maxwell 71-563 (Ac); Smitinand 8478 (Ac); Smitinand & Canaridas 11388 (Ac).

ERIOCAULON SOLLYANUM Royle

Additional bibliography: Moldenke, Phytologia 33: 15 (1976) and 34: 267, 274, & 403. 1976; P. Morat, Adansonia, ser. 2, 15: [463]. 1976.

Waas describes this plant as an herb with white flowers and found it growing in "limey areas on damp ground of roadsides".

Additional citations: INDIA: State undetermined: T. Thomson s. n. [Plan. Ganget. Sup.] (W—2501691). SRI LANKA: Waas 371 (W—2767933). THAILAND: Maxwell 72-506 (Ac).

ERIOCAULON SOLLYANUM var. SUMATRANUM Van Royen, Blumea 10: 135. 1960.

Bibliography: Van Royen, Blumea 10: 135. 1960; Moldenke, Phytologia 19: 78 (1969), 19: 346 (1970), and 21: 277. 1971; Moldenke, Fifth Summ. 2: 513. 1971; Moldenke, Phytologia 25: 126 (1973) and 34: 267, 274, & 403. 1976.

This variety is based on Bünnemeijer 8950 from Sumatra and Van Royen (1960) cites also Bartlett 7457, Boeea 5963, 6008, & 10343, Bünnemeijer 5203 & 5763, Junghuhn s.n., Lörzing 6729, and Robinson & Kloss s.n. from the same island. Hitherto I have regarded these collections as representing E. merrillii Ruhl. of the Philippine Islands and the specimens cited below were so reported by me previously. Certainly these Sumatran specimens very closely resemble the Philippine plants. Collectors describe its flowering-heads as "bluish-white", report the vernacular name, "si landit tano", and have found it in flower and fruit on high plateaus in April and also in flower from October to December.

Citations: GREATER SUNDA ISLANDS: Sumatra: H. H. Bartlett 7457

(Mi, N, W—1552243); Boeea 5963 (N), 6008 (N), 8764 (W—2275433, Z), 10343 (N).

ERIOCAULON SUISHAENSE Hayata

Additional bibliography: Sonohara, Tawada, & Amano [ed. E. H. Walker], Fl. Okin. 205. 1952; Moldenke, Phytologia 29: 232—233 (1974) and 34: 264 & 396. 1976.

Recent collectors have found this plant growing on footpaths along paddy fields and at the edges of streams, flowering and fruiting from June to August. Sonohara and his associates (1952) record it from "In wet soil in Kunigani, Nakagami, Kume, Ishigaki, Iriomote, and Yonaguni" in the Ryukyu Islands and list the Japanese vernacular names, "Okinawa-midzutamaso" and "Suisha-hishikusa" for it.

Material of this species has been misidentified and distributed in some herbaria as E. buergerianum Körn., E. truncatum Hamilt., and E. wallichianum Wight.

Additional citations: HONG KONG: C. Wright s.n. [Hong Kong] (W—46453). RYUKYU ISLAND ARCHIPELAGO: Okinawa: Hatusima 18099 (W—2243428); Walker, Sonohara, Tawado, & Amano 7120 (W—2094266); Walker, Tawada, & Amano 6479 (W—2093775). FORMOSA: A. Henry 1801 (W—455694); Kawakami s.n. [Herb. Taiwan 22295] (W—photo).

ERIOCAULON TENUIFOLIUM Klotzsch

Additional bibliography: Moldenke, Phytologia 29: 233 (1974) and 31: 360 & 384. 1975.

Goodland encountered this species in grassland with scattered trees, Curatella, Byrsonima, Trachypogon, and Fimbristylis being the dominant genera — flowering in August.

Additional citations: GUYANA: Goodland 515 (W—2548127), 921 [A] (W—2548128).

ERIOCAULON TEXENSE Körn.

Synonymy: Eriocaulon texensis Korn. ex G. W. Thomas, Tex. Pl. Ecolog. Summ. 32 & 100, sphalm. 1969.

Additional bibliography: G. W. Thomas, Tex. Pl. Ecolog. Summ. 32 & 100. 1969; Moldenke, Phytologia 33: 17 (1976) and 34: 274. 1976.

Thomas (1969) calls this the "Texas pipewort".

ERIOCAULON THAILANDICUM Moldenke

Additional bibliography: Moldenke, Phytologia 25: 83. 1972.

Smitinand refers to this as a "white-flowered herb" and found it to be "common" in lawns and savannas, at 20—150 m. altitude, flowering in November.

Additional citations: THAILAND: Smitinand 8394 (Ac), 8478a (Ac).

ERIOCAULON THUNBERGII Wikstr.

Emended synonymy: Eriocaulon natans Afzel. ex Moldenke, Résu-

mé Suppl. 1: 17, in syn. 1959 [not E. natans F. Muell., 1875].
Additional bibliography: Moldenke, Phytologia 29: 233. 1974.

ERIOCAULON THWAITESII Körn.
Additional bibliography: Moldenke, Phytologia 33: 17 (1976) and 34: 263. 1976.
Davidse and his associates found this species growing in wet soil at the base of dripping cliff-faces, along trails in montane forests, on flat rock outcrops with grassy areas on shallow soil and low trees around the margins, in grassy roadside ditches through tea plantations, on small wet rock outcrops, in shallow water of roadside ditches, and by permanent ponds with surrounding marshy areas, at altitudes of 33--1740 m., flowering and fruiting in October and November, and describe it as an annual with white flower-heads. Other recent collectors describe it as "very small plants", 3--5 inches tall, the flower-heads gray or brownish.
Additional citations: SRI LANKA: G. Davidse 7822 (Ld), 8508 (Ld); Davidse & Sumithraarachchi 7923 (Ws), 7956 (Ld), 8182 (Ld), 8638 (Ld), 8776 (Ac); Sumithraarachchi DBS.116 (W--2767931); Sumithraarachchi & Fernando DBS.128 (W--2767925); Sumithraarachchi & Jayasuriya DBS.170 (W--2767930), DBS.204 (W--2768301); Sumithraarachchi & Waas DBS.298 (W--2767924).

ERIOCAULON TRUNCATUM Hamilt.
Additional synonymy: Eriocaulon fruncatum Buch.-Ham. ex Sonohara, Tawada, & Amano [ed. E. H. Walker], Fl. Okin. 205, sphalm. 1952.
Additional & emended bibliography: Sonohara, Tawada, & Amano [ed. E. H. Walker], Fl. Okin. 205. 1952; Bolkh., Grif, Matvej., & Zakhar., Chrom. Numb. Flow. Pl., imp. 1, 274 (1969) and imp. 2, 274. 1974; Moldenke, Phytologia 33: 17--18 (1976) and 34: 264, 265, 273, 394, 396, & 402. 1976.
Sonohara and his associates (1952) apparently considered this species conspecific with E. miyagianum Koidz. [a synonym of E. sexangulare L.], but the two taxa bear scarcely any resemblance to each other. Maxwell describes E. truncatum as an erect herb having green stems and leaves and gray-white inflorescences and found it growing in open wet overgrown rice fields.
Material of E. truncatum has been misidentified and distributed in some herbaria as Lipocarpha argentea R. Br.
The "A. J." 4003, Carrick 837 & s.n. [3-5-1965], Kasim bin Rajab 5022, Soepadmo KLU.9133, and Tso 20015, distributed as E. truncatum, actually are E. australe R. Br., while Carrick & Enoch JC.148 is E. australe f. proliferum Moldenke, Ching 7814 is E. buergerianum Körn., M. Ramos s.n. [Herb. Philip. Bur. Sci. 41340] is E. infirmum var. puberulentum (Moldenke) Van Royen, Kawakami & Sasaki s.n. [Herb. Taiwan 5563] is E. sexangulare L., C. Wright

s.n. [Hong Kong] is E. suishaense Hayata, Sumithraarachchi DBS. 116 and Sumithraarachchi & Fernando DBS.128 are E. thwaitesii Körn., Poore 312 seems to be E. truncatum var. malaccense Hook. f., and Tso 22499 is something in the Cyperaceae.

Additional citations: CHINA: Hupeh: Faber s.n. (W--455907); A. Henry 2767 (W--800387). Kwangsi: Tsang 28306 (W--1757632). CHINESE COASTAL ISLANDS: Hainan: Tsang 535 [Herb. Lingnan Univ. 16034] (W--1248938). THAILAND: Maxwell 75-869 (Ac). PHILIPPINE ISLANDS: Luzon: Reillo s.n. [Herb. Philip. Bur. Sci. 19267] (W--900603). GREATER SUNDA ISLANDS: Sabah: Topping 1938 (W--1376773). Sumatra: Toroes 2581 (W--1703750), 4572 (W--1681400), 5024 (W--1681561).

ERIOCAULON TRUNCATUM var. MALACCENSE Hook. f.

Additional bibliography: Moldenke, Phytologia 25: 85--86 (1972) and 34: 265. 1976.

Citations: MALAYA: Selangor: Poore 312 (Kl--312).

ERIOCAULON WALKERI Hook. f.

Additional bibliography: Hocking, Excerpt. Bot. A.26: 89. 1975; Moldenke, Phytologia 33: 19. 1976.

Additional citations: SRI LANKA: Jayasuriya 2105 (N).

ERIOCAULON WELWITSCHII Rendle

Additional bibliography: Moldenke, Phytologia 29: 237 (1974) and 31: 388 & 398. 1975.

ERIOCAULON WILLDENOVIANUM Moldenke

Additional bibliography: Hocking, Excerpt. Bot. A.26: 90. 1975; Moldenke, Phytologia 33: 19 (1976) and 34: 265, 268, 273, 274, & 394. 1976.

Recent collectors refer to this plant as "semi-floating, floating or rooted in soft mud in lakes adjacent to Pandanus clumps and Lepironia marginal areas", with white flower-heads, and found it also in "swampy forests" and roadside ditches, at 100 feet altitude, flowering and fruiting in May and October. Johnson reports it "occasional in rather swampy 'wallum' on deep sand".

Material of this species has most often been misidentified and distributed as the closely similar E. sexangulare L. Poore 956 and B. C. Stone 12313 are mixtures of typical E. willdenovianum and f. viviparum Moldenke. On the other hand, Cushing 431 and Poore 95b, distributed as E. willdenovianum, are actually E. australe R. Br.

Additional citations: SRI LANKA: G. Davidse 7826 (Ld). HONG KONG: C. Wright 549 (W--46456). THAILAND: Smitinand & Abbe 6158 (Ac). MALAYA: Pahang: Poore 956, in part (Kl--956); B. C. Stone 12313, in part (Kl--22252). Trengganu: Kasim bin Rajab 5124 (Kl--5124). PALAU ISLANDS: Yap: Volkens 406 (W--617490,

W--775970). AUSTRALIA: New South Wales: L. A. S. Johnson 17733 (W--2038397).

ERIOCAULON WILLDENOVIANUM f. VIVIPARUM Moldenke

Additional bibliography: Moldenke, Phytologia 25: 88--89 (1972) and 34: 265. 1976.

Recent collectors refer to this plant as "semi-floating in lake adjacent to Pandanus clumps and Lepironia marginal areas or rooted in soft mud" or as a "floating mat, often viviparous", the inflorescence "a white round head, often with bulbils", flowers white, and have encountered it in herbaceous swamps and at the marshy edges of old mining pools, at 100 feet altitude, flowering and fruiting in October and November, flowering also in February and March. A pollen sample was taken from Flenley 41 according to a note on the Kuala Lumpur sheet.

Material of this form has mostly been identified and distributed as E. sexangulare L. Poore 956 and B. C. Stone 12313, cited below, are mixtures with the typical form of E. willdenovianum.

Additional citations: MALAYA: Pahang: Flenley 41 (Kl--13851); Poore 956, in part (Kl--956); B. C. Stone 12313, in part (Kl--22252). Trenggamu: Merton 4138 (Kl--4138).

ERIOCAULON WOODII N. E. Br.

Additional bibliography: Moldenke, Phytologia 29: 231 & 239 (1974) and 33: 153. 1976.

ERIOCAULON XENOPODION T. Koyama

Additional bibliography: Moldenke, Phytologia 25: 89. 1972.

Maxwell describes this plant as having white inflorescence-heads, black anthers, and no odor, and found it growing in open moist rocky marshes along roadsides, at 1000 m. altitude, flowering in August.

Additional citations: THAILAND: Maxwell 74-806 (Ac).

ERIOCAULON XERANTHEMUM Mart.

Additional bibliography: Moldenke, Phytologia 33: 19--20 (1976) and 34: 263. 1976.

Maxwell found this plant in fruit in October.

Additional citations: THAILAND: Maxwell 73-439 (Ac).

ERIOCAULON ZOLLINGERIANUM Körn.

Additional bibliography: Moldenke, Phytologia 29: 239. 1974; Hocking, Excerpt. Bot. A.26: 89. 1975.

Recent collectors have encountered this plant at altitudes of 200--1400 m., flowering and fruiting from November to April. Material has been misidentified and distributed in some herbaria as E. cinereum R. Br.

Additional citations: THAILAND: Maxwell 71-563b (Ac), 73-597 (Ac); Smitinand & Williams 8410 (Ac). PHILIPPINE ISLANDS: Luzon: McGregor s.n. [Herb. Philip. Bur. Sci. 14149] (W--714342), s.n.

[Herb. Philip. Bur. Sci. 19980] (W--901063), s.n. [Herb. Philip. Bur. Sci. 20172] (W--568418); E. D. Merrill 7362 (W--837459); Reillo s.n. [Herb. Philip. Bur. Sci. 19270] (W--900606).

ERIOCAULON ZYOTANII Satake

Additional bibliography: Moldenke, Phytologia 29: 239. 1974; Hocking, Excerpt. Bot. A.26: 89. 1975.

LACHNOCAULON Kunth

Additional bibliography: Holm, Bot. Gaz. 31: 18 & 33. 1901; Gleason, New Britt. & Br. Illustr. Fl., imp. 1, 1: 372, 374, & 480 (1952), imp. 1, 3: 568, 574, & 582 (1952), imp. 2, 1: 372, 374, & 480 (1958), imp. 2, 3: 568, 574, & 582 (1958), imp. 3, 1: 372, 374, & 480 (1963), and imp. 3, 3: 568, 574, & 582. 1963; Pilger in Engl. & Prantl, Nat. Pflanzenfam. Ergänz. 2, Nachtr. 3 zu 2: 38 & 40. 1908; Macbr., Field Mus. Publ. Bot. 11: 8. 1931; G. W. Thomas, Tex. Pl. Ecolog. Summ. 32. 1969; Hocking, Excerpt. Bot. A.26: 89 & 90. 1975; Duke, Phytologia 34: 25. 1976; Moldenke, Phytologia 33: 20--21 & 509 (1976) and 34: 390, 391, & 505. 1976.

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